THE UNIVERSITY OF ALBERTA

THE RELATIONSHIP BETWEEN KNOWLEDGE OF CORE AND SPECIALIZED VOCABULARY

by

© ROBERT KEITH JACKSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF ELEMENTARY EDUCATION

EDMONTON, ALBERTA

AUGUST, 1968

1968 (F)
103.

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled, "The Relationship Between Knowledge of Core and Specialized Vocabulary" submitted by Robert Keith Jackson, in partial fulfillment of the requirements for the Degree of Master of Education.

ABSTRACT

The understanding a reader obtains from the printed page is in part a function of the number and clarity of concepts the reader has fixed through words. Not only must the reader have a sufficient number of verbal concepts, but these must be of an abstract nature if they are to be applicable to a wide variety of verbal contexts. In order to read in a discipline, the student must possess verbal concepts for the words used primarily in the discipline as well as for the words used for communication in many disciplines. The former are called specialized words while the latter are core words. It is the task of the reading program to develop the abstract verbal concepts necessary for comprehension of all written material.

The purpose of this study was to investigate the relationship between the knowledge of core and specialized vocabulary of grade six students. The sample consisted of two groups of twenty-five subjects each, stratified on the basis of achievement in mathematics. Scores from the Lorge-Thorndike Intelligence Test, the California Reading Test, and the Sequential Tests of Educational Progress, reading section, together with the subject's age in months and sex were recorded. A sixty word test of core and specialized vocabulary was administered to each subject. The oral responses were categorized according to the scale hypothesized by Gerstein.

Statistical analysis utilizing "t" tests of significance was made for the difference between the mean number of definitions in each category for core and specialized vocabulary for both groups. Multiple Linear Regression models were used to determine whether the variables of intelligence quotient, reading test score, age, sex, and group membership contributed significantly

to the prediction of the qualitative vocabulary scores of the subjects when group membership was held constant. In addition, an analysis of the word definition errors and of the logical qualities of the definitions was undertaken.

Significant differences were found to exist between the knowledge of core and specialized vocabulary of both groups. Standardized reading test score and verbal intelligence quotient were found to be significant predictors only of the conceptual and error categories of response to a core vocabulary. Sex, age and non-verbal intelligence quotient were not found to be significant predictors of the qualitative vocabulary scores.

The most common types of errors were omission, repetition without explanation, and wrong definition. An analysis of the logical qualities of the definitions failed to reveal significant differences between the definitions given by the high and the low groups.

The results appear to indicate that the knowledge of core and specialized vocabulary of grade six students differed significantly in terms of its quality. This may indicate that the vocabulary development which took place in the reading program was not of such a nature that it readily transferred to vocabulary knowledge in other areas not directly studied.

Implications of the findings appear to indicate the possibility of needed revisions in the vocabulary development skills of the reading program and the necessity of exploring the assumption of transferability of reading instruction to other reading tasks.

ACKNOWLEDGEMENTS

Many people have assisted in making this study an interesting and valuable learning experience.

The encouragement and assistance of Dr. P. A. Lane, chairman of the thesis committee, are gratefully acknowledged. Dr. J. K. Bishop and Prof. N. M. Purvis served on the thesis committee and offered constructive advice. Special thanks are extended to Mr. Daiyo Sawada for his assistance with the statistical procedures.

Thanks are also extended to the Edmonton Public School Board for their cooperation and to the principals, teachers and children in schools involved in this study.

The writer wishes to extend sincere thanks to his colleagues in the Department of Elementary Education for the many hours of discussion which contributed to this study.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE PROBLEM

I. INTRODUCTION

The curriculum of the elementary school has, in the past decade, placed increased emphasis on teaching those concepts that are integral to understanding in a discipline. Indicative of this trend was the introduction of the new mathematics programs in the elementary schools of Alberta approximately ten years ago. During the 1968-69 school year a new science program will be taught in the elementary schools. Each of these programs attempts to teach the child the basic concepts that structure the discipline.

The increased intellectual rigour of the new courses in the various disciplines is placing greater demands upon the reading ability of the students. Students are required to read widely in a variety of resource books which are technical in nature. Reading to gather information has become an important part of the "Discovery" method of teaching. One particular difficulty of the student in reading in the disciplines lies in the area of vocabulary knowledge. Not only must the student know the meanings of the words that he may encounter daily, but also of the words related to the concepts of the discipline. Recent research such as that of Jay (1950), Burks and Bruce (1955), and Jan-Tausch (1960) has indicated that the understanding a reader obtains from the printed page is in part a function of the number and clarity of concepts the reader has fixed through words.

Reading programs have long been aware of the need to train the student so that he is able to read in the disciplines. Inspite of this recognition of the problem, instruction has been based largely on the basal series. It has been hoped that this instruction would have transfer value to other types of reading material. Thus, since the reading program is limited by time, teaching for transfer of training to other types of reading material is the basis of reading instruction.

Belief in the transfer of training of the skills required to break the code in reading, skills such as the ability to attack a word phonetically, would appear to be justified since the nature of the stimulus remains relatively constant. However, transfer of training for other skills and abilities essential to reading may be less certain. In particular, does the training in vocabulary development, the development of verbal concepts, in the reading program enable the child to read in the disciplines?

The vocabulary contained in the reading series, which shall be called <u>core</u> vocabulary in this study, is very often entirely different from the vocabulary contained in the texts in the disciplines, which shall be called <u>specialized</u> vocabulary in this study. Indicative of this fact is a study by Stauffer (1966) of the vocabulary contained in the texts of the reading series and the disciplines at the primary level. He examined seven different reading series and three different series in three content areas. In the reading series he counted each new word used while in the content series he counted every different word in each text. A master list was made up for each of the series and after analysis Stauffer (1966) concluded:

> even if a child mastered all the different words presented in all of the seven reading series he would still need to learn to read at least one-half of the words presented in the arithmetic series in arithmetic class (p. 144).

Thus, it would appear that vocabulary development in reading class is unlikely to help the child know the meanings of words in the disciplines. If transfer does take place, if the reading program is helping the child acquire the vocabulary he needs to read in the disciplines, it must be in terms of some sort of ability to acquire verbal concepts. Thus, it may be transfer in terms of the nature of word knowledge and it would seem reasonable to assume that it would be reflected in the quality of the student's knowledge of the two types of vocabulary, core and specialized. If the quality of the knowledge appears to be different it is possible that the present program of reading instruction is deficient in at least one area in equipping the student to read in the disciplines.

There have been two studies of the relationship between student's knowledge of the two types of vocabulary, core and specialized. Russell (1954) conducted a study of the development of general and specialized vocabularies in grades four to twelve. He administered separate multiple-choice tests of general vocabulary as well as social studies, science and mathematics vocabularies. He concluded that while there was a positive correlation between the test scores achieved on any one test and the other three, the results indicated the possibility of specific development of the specialized vocabularies. In addition, there was some evidence that girls developed specialized vocabularies somewhat earlier than boys. He concluded the need for further research

on this problem, especially in grades four through six (p. 363).

Vanderlinde (1962) in an experimental study designed to show the effects of direct teaching of arithmetical terms on arithmetic problem solving ability, compared the pre- and post- test results of grade five subjects on a test of general vocabulary. He found that the direct teaching of arithmetical terms improved arithmetic problem solving and knowledge of arithmetic concepts, but had no effect upon knowledge of general vocabulary. This finding suggests that the transfer of learning from one type of vocabulary to another is not automatic and the learning of one type of vocabulary may not improve the learning of the other type of vocabulary.

It would appear, therefore, that one important area of vocabulary knowledge in the elementary school has not been fully tested or investigated, that is, the relationship between children's knowledge of core and specialized vocabularies, as they are defined in this study.

II. PURPOSE OF THE STUDY

The purpose of this study is to investigate the relationship between the knowledge of core and specialized vocabulary of grade six children in the elementary school. Mathematical terms derived from the mathematics textbook series authorized for use in Alberta during the 1966-67 school year will be the specialized vocabulary investigated.

III. DEFINITION OF TERMS

For the purposes of this study, the following definitions will

be used.

Core or General Vocabulary - derived from Lado (1957). A core vocabulary contains those words known to almost all members of a culture as a result of a commonality of experience. These words are used for written communication in many fields of study.

Specialized Vocabulary - derived from Lado (1957). A specialized vocabulary contains those words known to a group within the culture as a result of specialized experience. These words are used for written communication primarily in one field of study.

Qualitative Analysis - This term refers to a method of classifying definitions given to a stimulus word using the scale hypothesized by Gerstein (1949). The responses are placed in one of the three levels of correct responses or in the error category.

High Achiever in Arithmetic - is defined in this study as a grade six student who obtained a percentile rank greater than seventy-five, in terms of local norms for a system-wide standardized arithmetic exam.

Low Achiever in Arithmetic - is defined in this study as a grade six student who obtained a percentile rank below twenty-five, in terms of local norms for a system-wide standardized arithmetic exam.

Intelligence Quotient - in this study is the converted score achieved by a subject on the Lorge-Thorndike Intelligence Test form A, level 3 administered in February, 1967.

Concept - an abstraction in the form of a statable function or rule representing the system of identity for a class or a series of classes of objects or events (Hunt, 1962).

IV. HYPOTHESES

The following null hypotheses are considered:

1. There is no relationship between the qualitative level of the definitions given to core and specialized vocabularies by a group of high achievers in mathematics and a group of low achievers in mathematics.
2. There is no relationship between the qualitative level of definitions given to specialized vocabulary by a group of high achievers in mathematics and a group of low achievers in mathematics.
3. There is no relationship between the qualitative level of definitions given to core vocabulary by a group of high achievers in reading and a group of low achievers in reading.
4. There is no relationship between the qualitative level of definitions given to core or specialized vocabulary and I.Q. score.
5. There is no relationship between the qualitative level of definitions given to core or specialized vocabulary and sex.
6. There is no relationship between the qualitative level of definitions given to core or specialized vocabulary and age.

V. QUESTIONS

In addition, the following questions seem relevant.

1. What are the types of errors most commonly made in response

to core vocabulary?

2. What are the types of errors most commonly made in response to specialized vocabulary?

VI. DESIGN OF THE STUDY

A sample of fifty children was chosen from a grade six population in two Edmonton schools. Twenty-five were high achievers in mathematics and twenty-five were low achievers in mathematics as defined in this study. All students must have been in the new mathematics program at least two years. The sample was chosen according to the following procedure:

(1) The results of the most recent standardized arithmetic test were taken from the cumulative record card for each child and, when necessary, converted into a percentile score.

(2) Each pupil who achieved a score which fell above the seventy-fifth or below the twenty-fifth percentile on the arithmetic test was listed.

(3) The cumulative record card of each child listed was checked and those pupils were eliminated whose record card was incomplete or who had come to Edmonton within the preceding two years.

(4) Each child in the resulting list was assigned a number and twenty-five were chosen from those above the seventy-fifth percentile and twenty-five were chosen from those below the twenty-fifth percentile by means of a table of random numbers.

A sixty word vocabulary test was administered to each subject. The test, which contained thirty core words and thirty specialized words, was constructed specifically for this purpose. All the testing was done by the investigator. Each subject responded orally to the stimulus word which was presented to him in written form. The responses were tape recorded and transcribed by the investigator on the same day. The resulting transcription was then typed onto sheets and the responses were analyzed qualitatively. The results of the analysis together with the information collected from the cumulative record cards were punched onto computer cards. Statistical analysis, by means of "t" tests and Multiple Linear Regression, was performed.

VII. LIMITATIONS OF THE STUDY

The study is limited in the following ways:

1. The task of defining words orally represents only one aspect of vocabulary knowledge. In defining a word a child may be limited by his power of expression or may verbalize a definition without complete understanding.
2. The subjects represented a stratified sample of high and low achievers in mathematics. Thus, the results may only be generalized to apply to the two extreme populations and not to the large middle group.
3. Measures of intelligence, reading ability and achievement in mathematics were in terms of group tests which are not as valid or as reliable as individual tests and this may result in a higher error in measurement.

4. The study did not attempt to investigate other variables, such as socio-economic status, which affect vocabulary development.

VIII. SIGNIFICANCE OF THE STUDY

It is hoped that the results of this study will indicate whether or not a child's knowledge of core vocabulary is related to his knowledge of specialized vocabulary, as the two terms are defined in this study. Should it be proven that the two are not closely related, this could directly affect the type of vocabulary testing done in the elementary schools. Vocabulary testing would then have to be in terms of core vocabulary and specialized vocabulary for each of the disciplines. More important, however, the results could affect the type of vocabulary taught in the reading program and the manner in which vocabulary is taught. The results could indicate whether or not it is necessary to teach the meanings of specialized vocabularies in the reading program in order to equip the student for reading in the disciplines. In addition, a lack of relationship between the quality of children's knowledge of the two types of vocabulary may indicate the necessity of teaching the ability to formulate verbal concepts rather than specific word meanings.

IX. PLAN OF THE RESEARCH

In Chapter I the problem was identified and the study was outlined. The results of previous research studies and literature, related to the problem are presented in Chapter II. Chapter III describes the sample,

the testing instruments and procedures, the method of qualitative analysis and the statistical procedures. The results of the statistical analysis of the data and their interpretation are presented in Chapter IV. Chapter V contains the conclusions based on the findings and the implications for further research.

CHAPTER II

REVIEW OF THE LITERATURE

The review of the research is organized into four sections. The first section deals with concepts, their nature, development, relationship to language and role in cognitive behaviour. The second part examines concept development as it has been studied through the analysis of verbal definition of children and adults. A discussion of the relationship between concept development and reading ability, the third section, is followed by a brief review of studies related to the vocabulary of mathematics.

I. CONCEPT FORMATION

Since concepts may be thought of as the psychological embodiment of organized knowledge, their role in education is crucial. Most school experiences are designed to foster an understanding of some phenomena and the development of concepts is an integral part of this process of education. Russell (1956, p.126) has indicated that the clarity and completeness of a child's concepts provide two of the best measures of his probable success in school. Concepts, therefore, are basic to school learning.

Characteristics of a Concept

Numerous psychologists have attempted to describe a concept. One of them, Vinacke (1952), has reviewed the research and has listed five general characteristics of a concept. He states:

> 1. Concepts are not direct sensory data but something resulting from the elaboration, combination, etc. thereof ...
> 2. A corollary of the first property thereof is that concepts depend upon the previous experience of the organism.
> 3. Concepts are systems within the mental organization which tie together, link or combine discrete sensory experiences.
> 4. It may be inferred that such ties or links are symbolic in nature; that is, the same concept may be invoked by a variety of stimuli. In the human organism, words usually fulfill this symbolic function.
> 5. On the side of the internal processes of the organism, concepts represent selective factors. An external stimulus arouses a symbolic response, on the one hand, or a symbolic response guides perceptual activity, whichever comes first ... (p. 100).

For the purposes of this study, two general characteristics of a concept seem to be of special importance. The first is that concepts are derived from concrete experience but involve going beyond the sensory data of the experience in order to organize this data. This organization gives the object or event abstract class identity. Classification systems, such as the one used in this study, classify responses on a concrete to abstract continuum as the organization of the data results in an increasingly abstract class identity for an object or event.

The second characteristic is that the verbal label is not the concept, it merely stands for the internal organization which is the concept. However, these labels may allow internal manipulation of the concept and, thus, the creation of new concepts. A study which concentrates on these verbal labels must recognize that they are not the concepts, but that their study may indicate the complexity of the internal organization.

The Role of Concepts in Thinking

A concept, as described above, is the result of a reorganization of past and present sensory data into systems which combine this data in such a manner that two or more dissimilar stimuli may invoke the same response, due to symbolic integration of the data. Numerous psychologists have stressed the importance of concepts to intellectual life.

Bruner (1962, p.p. 12-13) has summarized the achievement of categorizing as follows:

1. it reduces the complexity of the environment - a variety of dissimilar stimuli may be responded to on the basis of similiar criterial attributes;
2. it is the means by which objects of the world about us are identified - objects or events are placed into a class on the basis of their criterial attributes while irrelevant attributes are ignored;
3. it reduces the necessity of constant learning - the abstraction of defining attributes allows further categorizing without need of future learning;
4. it provides direction and planning for activities - the stability of the abstracted defining attributes allow knowledge of a situation in advance;
5. it permits ordering and relating classes of events - category systems relate events so that a single object or event may arouse other related objects or events.

In addition, Bruner (1966, p. 37) has stated that conceptualization permits the mental creation of objects or situation which do not or have not yet existed in the physical world, an example of the ability of

conceptualized knowledge to go beyond sensory information. Vinacke, (1952, p. 98), in a review of research, wrote that concepts link the individuals present perceptions and learning to his previous experience, and thereby overcome some of the limitations of time.

Russell (1956, p. 119), while reviewing the research on concepts and its import for educators, claimed that the acquisition of a concept increases the ability of an individual to convey meaning to others.

Concepts and Language

Psychological and educational researchers have devoted considerable attention to the relationship between concepts and language. In general, while some psychologists, such as Archer (Melton, 1964, p. 238), claim that concepts are identical with meaningful words, most, such as Bruner (1962), believe that non-verbal concepts are possible. This does not refute the close association between language and concept formation.

Vygotsky (1962, p. 51) claimed that in word meaning thought and speech were united into verbal thought which was then communicable. A word, which refers to a class of objects rather than to a single object, is therefore already a generalization. It is the generalized reflection of reality which distinguishes thought from sensation and so naming is an act of thought. Luria (1964) has similarly stressed the abstracting and generalizing function of speech which mediates the stimuli acting upon the child and enables a complex, self-regulating system of thought and volitional action. Vygotsky (1962, p. 105) stated that the school years were the optimum period for instruction in the conscious control of verbal thought.

Bruner (1962) concurs with Vygotsky that a word may represent a concept. Carroll (1964, p.186), a researcher and theorist in the field of language, has written that many words come to stand for concepts that have been learned pre-verbally and that the word must evoke the concept and the concept must evoke the word. Numerous psychological experimenters have examined the role of language in concept formation and utilization. Experimenters such as Rasmussen and Archer (1961), Goss and Moylan (1958), Corey and Goss (1957), and Ewart and Lambert (1932) have in general supported the hypothesis that language facilitates acquisition and utilization of concepts. A general statement of their conclusions has been given by Goss (1961).

> Without the postulation of common verbal respones to subsets of stimuli whose members are highly dissimiliar physically, generalization of a common terminating response from one stimulus of a subset to other stimuli of the subset would be precluded (p. 255).

Vinacke (1952), in a review of the research, stated that the word is a label for the internalized concept. Concept formation included not only an accumulation and organization of experience, but also the symbolic labelling and manipulation of the resulting organization. The word may then serve to organize future experience or as a stimulus to activate the concept formation. Thus, while the word is not the concept, Vinacke appears to believe that concept formation involves the symbolic labelling of the concept by a word.

Scheerer (1954) has summarized the relationship between the word and the concept as follows:

> the meaning of the word is symbolic. First, the sound patterns come to represent something different from what

> they are as mere sounds. Second, the word is an expression of generalizing thought which culminates in genuine concept formation. Concepts are psychologically operative when the invariant can be abstracted from a variety of changing aspects. The process in turn makes the word a conceptual symbol. The name for an individual object in daily life does not refer to the specific uniqueness of an object; the name signifies the object as a representative of a category-an exemplification of all the possible variations allowed for by its invariant characteristics (p. 128).

One of the methods that has been used extensively in testing concepts has been the verbal definition of words. Carrol (1964) has stated:

> The use of a formal definition, on the one hand, literally "marks off the boundaries of" the concept by first indicating what it has in common with other experiences (genus) and then indicating in what respects or attributes (differentia) it differs from other experiences (p. 188).

Bourne (1966), in a review of research on concepts, tended to agree that verbal definition was an adequate test of concepts. However, Russell (1956), in an earlier review, cautioned that definitions may be memorized and parroted back without any meaning being attached.

Development of Concepts

The development of various concepts in children has been studied by numerous researchers. A general summary of the research in this field by Russell (1956) included eight categories of concepts possessed by children. They were: (1) mathematical concepts, (2) concepts of time, (3) scientific concepts, (4) concepts of the self, (5) social concepts, (6) aesthetic concepts, (7) concepts of humour, and (8) miscellaneous concepts. Russell stressed that there is much overlapping in content and very often a child may be employing concepts of several types.

In general, most psychologists would agree with Vinacke that the development of concepts involves two mutually dependent processes, abstraction and generalization. The term "discrimination" is often used in place of the term "abstraction". Vinacke (1952) has stated:

> Abstraction signifies the linking of one sensory experience to another, during which some details are left out and others become dominant (in this sense, the concept is a symbolic response for these dominant details). Generalization signifies that the dominant detail (or groups of details) resulting from abstraction is used as a basis for responding similiarly to the separate objects linked by abstraction, and for responding to other objects similiarly linked (p. 104).

Different authors have stressed either one of these processes in the development of concepts and two schools of thought have grown up. Bourne (1966), in a review of the research, summarized the difference in views as follows:

> One line pictures the organism as a passive recipient of information from his environment. Each example of the unknown concept provides him with an additional bit of knowledge ... A second and seemingly opposed line of theory pictures the subject as an active participant in the process of forming concepts. It asserts that an organism always entertains some hypothesis about the unknown concept (p. 25).

The study of concepts in children of various ages has resulted in the observation of developmental trends. Researchers such as Curti (1950), Buhler (1930), Welch (1940), and Welch and Long (1940) have suggested that throughout the period of development of concepts there may be noted a number of stages or levels of growth that can be distinguished from each other. The work of the psychologist Piaget is significant in this area.

Piaget and his associates (1958, 1959) have studied, over a long

period of time, the mental development of children and have formulated a comprehensive theory of that development. This theory is scattered throughout a number of works, but has been gathered and reviewed by Flavell (1963). In general Piaget believes that mental processes grow out of basic organismic processes. Adaptation of the organism to the environment consists of the interaction between the processes of assimilation and accomodation. Maturity is reflected in the relative equilibrium of these two processes and an immature stage involves the preponderance of one of the processes. Accommodation is the action of environment upon the organism that results in the modification of existing schema. Assimilation is the organism modifying the environment in the form of cognitive structuring of the objects and events in the environment.

The stages through which the organism passes may be summarized as follows:

1. Sensori-motor stage (birth to approximately one-and-a-half years): this stage is characterized by the gradual organization of sensory-motor actions in the immediate environment. It involves only perceptual and motor acts and not symbolic ones.

2. Preoperational stage (about age two to seven): This stage is characterized by the child's first attempts to come to grips with symbols.

3. Concrete operations stage (about ages seven to eleven): This stage is characterized by the child's conceptual organization of the surrounding environment through the formation of cognitive structures called groupings.

4. Formal operations stage (about ages eleven to fifteen): The appearance of cognitive structures isomorphic to groups and lattices of logical

algebra allow the child to organize the abstract, propositional world of possibility through the use of symbols.

There has been much discussion of the research and theory of Piaget. Many experimenters have attempted either to confirm or to reject part or all of the theory by empirical means. One such recent experiment is that conducted by Wolman and Barker (1965) which used the method of verbal definition to test the change from one stage of development to another. Their results failed to agree with those of Piaget.

Ausubel (1963) has suggested a modified version of Piaget's theory stressing the role of language at the different stages. At the preoperational stage, language is used to represent objects and experience, but these verbal representations cannot yet be manipulated internally to solve problems or comprehend new ideas. At the concrete operational stage, behaviour and learning come under verbal or symbolic control. It is now possible to manipulate ideas internally, but the ideas are still dependent upon recent concrete, empirical experience. At the abstract operations stage, about junior high school age, it is possible to manipulate ideas internally without any reference to sensory experiences. The hypothetical becomes possible through the use of language as a symbol system.

Factors Affecting Concept Formation

Vinacke (1952, p. 105) has included age, intelligence, training or experience, socioeconomic status and vocabulary as factors affecting concept formation in children. Age appears to affect a qualitative change in the ability of children to form concepts. Experience provides the raw data for concept formation and thus intelligence, which affects

the ability to profit from experience, and socioeconomic status, which affects the type of experiences of the child, play an important role in concept formation.

Bruner (1957) has proposed four general sets of conditions that may be relevant: (a) set or attitude, (b) need state of the individual, (c) the degree of mastery of the original learning from which a more generic coding system must be derived, and (d) diversity of training. Carroll (1964) has stated that the individual must experience both positive and negative instances of the concept to be learned, although Bruner (1962, pp. 62-63) indicates that negative instances are of less value to subjects than positive instances.

Russell (1956) has suggested five causes of errors in children's concepts. They are: (a) errors in the percepts from which the concepts emerge, (b) confusion between the images and memories aroused during recall, (c) lack of experience to check or validate the generalization reached, (d) set or suggestibility caused by certain features of the environment being more influential than others equally important, and (e) overconfidence in the results of one's observations and conceptual thinking. Since Russell is speaking primarily to educators his suggestions are highly applicable to the school setting.

Summary

Concepts appear to be highly complex psychological phenomena resulting from the organization of sensory data into abstract systems. They are crucial to learning in school as they play such an important role in the mental life of the individual. Although the complex relationship between concepts and their verbal labels has not yet been

definitely explained, language appears to faciliate the acquisition and utilization of concepts. The study of an individual's language may reveal the complexity of the internal organization which the verbal labels stand for. Concepts appear to develop as the individual matures, one line of development running from the concrete to the abstract. The complexity of the internal organization of concepts has been studied by classifying the verbal labels in terms of a concrete to abstract continuum. The development of concepts is subject to individual differences, and qualitative differences in the concepts of individuals of varying ages and background are discernible.

II. QUALITATIVE ANALYSIS OF THE DEVELOPMENT OF VOCABULARY RESPONSES

Researchers have long been interested in the nature of the vocabulary responses of children and adults. Implicit in this research is the assumption that the task of verbal definition is an adequate test of concept development. Several early studies were undertaken by educators. An 1896 study by Barnes (Werner & Kaplan, 1952, p. 95) dealt with the definitions of children from six to fifteen years of age. The findings revealed a steady decline of definitions formulated in terms of concrete action from 82% at the six year level to more than 50% at the ten year level and to 33% at the fifteen year level.

In 1904 Chambers (Gray & Holmes, 1938, p. 10) conducted a study of the growth of meaning vocabulary. A sample of 2,922 subjects, from the age of five to twenty-seven, was asked, "What do you mean by the words 'monk', 'peasant', 'armor', 'nation' and 'school'?" The responses he received fell into four categories, (a) no answer, signifying absence

of content, (b) wholly wrong, (c) vaguely right, possessing one or more correct features, and (d) wholly correct. Analysis in terms of age levels revealed a general pattern of development through the above four categories. Although a wrong definition was not a prerequisite for ultimate knowledge of the meaning of a word, when the wrong answer tendency was present, it was considered to be part way between no content and right content. A common source of error was "euphonic analogy", or the tendency to respond to the stimulus word in terms of a similiarly sounding word, for example, "monkey" in response to the work "monk". Chambers also indicated that the younger subjects had an accurate knowledge of only those things which were most immediate and familiar. He also concluded that in studying the development of the child's use of language a most fruitful field was found in an analysis of the quality and expansion of vocabulary during school years.

A study by Kirkpatrick (Gray & Holmes, 1938) in 1907 revealed not only an increase with age in the total number of words known but also a change in the nature of the definitions given. After analyzing the definitions of subjects of varying ages he concluded:

> Descriptions which are so common in the high school and college papers are rarely or never given by children in the kindergarten and primary grades. The same is true of definitions by synonyms and inclusions under larger terms. The younger children nearly always define by mention of some specific incident, eg. "a chair is to sit on"; "baby stands up in a chair"; "a bee goes around a piazza and makes a noise". What anything can do, or what can be done to it, or with it, is of most importance in early knowledge of all things, hence we find the definitions of children expressing action and use more than anything else . . . (p. 17).

Thus, while the nature of the definition was not exclusive to any age group, there was a strong tendency for the younger subjects to define in terms of the specific and the functional and the older subjects in terms of the generic and the descriptive.

A 1912 study by Pohlman (Werner & Kaplan, 1963, p. 188) of the meanings of words given by school children revealed again a qualitative difference in the definitions given by younger and older subjects to the same stimulus word. The verbal concepts of the younger subjects, between the ages of five and six, as revealed by their verbal definitions, were rooted in very specific, concrete, action-contexts. Thus, typical definitions for bottle were: "There's lemonade in it; Where you put water; When a little boy drinks milk out of it; Where you pour something out of". Typical definitions given by older subjects for the same word were: "that's a hollow, round glass vessel into which one pours drinks" (child of 12:0); "a container into which all kinds of liquids go" (child of 13:0). The development appears to have been towards a relatively context-free, generic type of definition.

Gray and Holmes (1938) stated that there were four qualitative attributes of meaning: (a) richness, (b) accuracy, (c) organization, and (d) clarity. While breadth of experience is indicated by the number of words to which meaning is attached, accuracy of thinking may be indicated by the clarity and exactness with which words are used. In discussing the development of meaning they indicated a change in the character of definitions attached to words from the lower to higher grades. They concluded that the period from nine to fifteen was an important one in the acquisition of meaning.

A number of psychological researchers have reported on the vocabulary responses of school children. A study was conducted in the Szeged area of Hungary by Baranyai (1958) between 1939 and 1941, but it was not published until 1958. The object of the study was to trace the development of verbal comprehension of words and phrases taken from reading books in 556 children aged eight to ten years, as shown by oral definition. She found that it was characteristic of the age group to simplify the level of the original meaning of the expression by reducing the abstract to the sensory level and to simple action. Sometimes if a child did not know a word he would associate it with a similiar sounding one. A group which was retested one year later with the same list showed, in many cases, interpretations on a higher level the second year. For example:

> Describing meaning of action instead of its simple motor function: "The farmers are busy in the fields"; "busy" is explained in the
>
> | first year | second year |
> | --- | --- |
> | they sow | they work fast (p. 264). |

She concluded that children 8 - 10 years old did not understand abstract expressions or topics of an abstract nature and therefore phrases and expressions in readers should convey visual images rather than abstract concepts. She also concluded that the results justified the use of a concrete to abstract scale to grade the verbal responses to the words and phrases.

Burns (1960) examined the written definitions of 3,600 secondary school children in Leeds. He used both logical and psychological criteria, the logical dealing with the form of the definition and the psychological dealing with the maturity of the definition. He indicated

that analysis solely in terms of logical criteria was inadequate and that only by including both sets of criteria would analysis be meaningful. He discovered three psychological categories of definitions with levels within the categories. Definition by emotional tone appeared to be the most rudimentary type of definition and often had little social value. Definition that associated meaning with a specific situation suggested a more socialized and mature level. Generic definitions appeared to be the most highly developed type. Children at age thirteen or fourteen appeared to use all types of definitions with words that they did not know well commonly defined in simpler, less mature ways than words they knew well. A number of the definitions seemed to illustrate a regression from a broader concept, which the individual was unable to explain, to a narrower definition based on some specific experience. Burns noted that the use of phrases such as "kind of", "like a", or "sort of" seemed to indicate an awareness of the need for a generic definition but an inability to express it.

Researchers such as Chambers, Kirkpatrick, Pohlman, Baranyai and Burns have studied the development of children's vocabulary at various stages in their growth. In general, the results of these studies indicate the presence of a progressive change with age in the nature of the quality of children's verbal definitions.

Psychologists interested in intellectual assessment have contributed greatly to the knowledge of the nature of children's verbal responses to stimulus words. The 1905 edition of the Binet and Simon (1916) intelligence tests included a vocabulary subtest. The answers given were classified as being one of the following: (a) silence, simple repetition, or

designation by gesture, (b) definition by use only, or (c) definition superior to use. In 1916, Terman (1937, p. 302) reported differences in types of definitions with children of different ages. While children of six defined objects, as a rule, in terms of use, by eight two-thirds of the children gave definitions superior to use, that is, in terms of description. In spite of this, the nature of the definition was not taken into consideration in scoring this edition of the test.

Wechsler (1944) has indicated the reason for the interest in the nature of vocabulary responses of psychologists concerned with intellectual measurement. He has stated:

> In defining a word, a subject gives us more than its mere meaning. In many instances he tells us a good deal about himself, or at least about the quality and character of his thought processes (p.99).

Werner and Kaplan (1952) examined the development in children of the ability to learn the meaning of words through verbal contexts. They designed a test in which the subject was to discover the meaning of a nonsense word by reading it in six sentences of increasing specificity. They found that in younger subjects the word acquired a wide and often diffuse contextual connotation (holophrasis); it was often fused with other concepts (syncresis) and its meaning might be readily altered (fluidity) (p. 77). They attributed this partly to the "primary verbal rigidity" of younger subjects which resulted in the strong embeddedness of the particular solution in the sentence context (p. 90). Verbal flexibility, as exhibited by the older subjects who were more able to do the test, presupposed a more or less abstract-symbolic attitude toward language. They concluded that as the child advanced in age, the word became more and more self-contained semantically and structurally.

A tendency for the younger subjects to determine the meaning of an artificial word by the sound pattern was also noted.

Two studies were conducted, under the supervision of Terman, in an attempt to develop an objective scoring method for grading various types of responses to the Stanford-Binet Vocabulary Sub-Test. Marx (1928) analyzed the responses of over one thousand children and two hundred adults to the first fifty words of the 1916 Stanford-Binet vocabulary section. After classifying all of the responses, she found that the following categories appeared most often: synonym or synonym type, genus, description, species, example or illustration, use, repetition and interpretation in connection with a situation (p. 148). Marx concluded that definition by synonym and genus type were, as a rule, of high quality while those of description and species were of fair quality. In addition, those of illustration, example, use, repetition, and interpretation in connection with a situation were of poorer quality in relation to chronological age.

The second study, conducted by Green (1931), attempted to discover a system of small weights which would credit responses to the Stanford-Binet vocabulary section in proportion to their relative superiority of inferiority. The responses of seven hundred and eighteen subjects between the ages of six and eighty-four to fifty vocabulary words were analyzed. A system was devised whereby the value of a type of response was determined according to the age of the subject giving that response. The median chronological ages for types of responses to words were converted into weights of 1, 2, and 3. Green discovered that the types of responses which had

a lower median than use were description, repetition in context, and demonstration.

Green noted the tendency of the child to see things in terms of the concrete. The subject's definitions also revealed a gradual development of the ability to see abstract relations. The child's inability to abstract lead him to perceive the word as a part of a whole and not as a separate entity. Thus, the nine year old defines "rule" as a "rule is not to go on the grass or anything" (p. 12). The tendency of the child to see things in concrete terms leads him often to look for a source. Thus, the child's idea of "roar" involves a concrete source of the phenomenon and so he may define it as "a lion roars". Forty-five of the fifty words Green used later became the Form L Vocabulary Test of the 1937 Revised Stanford-Binet.

The findings of the above studies were furthered by two psychological researchers, Feifel and Lorge. Feifel (1949) examined the qualitative differences in the vocabulary responses of normals and abnormals to the vocabulary section of the 1937 revision of the Stanford-Binet Intelligence Test. He analyzed the responses of 185 normal and abnormal adults between the ages of fifteen and eighty using a scale derived from the work of Green. Feifel found that the abnormal adult's responses were very similar to the children's responses in the Green study.

Shortly afterward, Feifel and Lorge (1950) examined the responses of nine hundred school children to the Form L Stanford-Binet Vocabulary Test. The sample ranged in age from six to fourteen years, with one-hundred children almost equally divided according to sex at each year level. The five level scale developed by Feifel in the previous study

was used for classifying responses. The categories were labelled: (1) synonym, (2) use, description, and use and description, (3) explanation, (4) demonstration, repetition, illustration and inferior explanation, and (5) error. While stressing that not all words permitted a full range of qualitative differences to express themselves and that no particular type of definition response was exclusive to any age group, they concluded that:

> the older children significantly more often use the explanation and synonym types of definition, whereas the younger children significantly more often employ the use and description, and demonstration, illustration, inferior explanation and repetition types of responses (p. 16).

These qualitative differences in the definitions of younger and older children were thought to be a reflection of the characteristic differences that exist in the thinking of younger children when compared with older children. While younger children perceived words as "concrete" ideas and emphasized their isolated or particular aspects, older children perceived and stressed the abstract or "class" features of the word meanings. A more thorough examination of word definition errors, category five, was carried out later by Feifel (1952).

A second classification scheme was developed at approximately the same time as that of Feifel and Lorge for use with the vocabulary responses of the Wechsler-Bellevue Intelligence Test. This theoretical system was set forth by the psychologist Gerstein (1949). While placing emphasis upon the relationship between the use of language, as manifested by a verbal definition of a stimulus word, and the underlying cognitive process, Gerstein suggested that the results of a study by Reichard, Schneider and Rapaport (1944) might prove applicable

to classifying vocabulary responses. These three researchers used the Goldstein-Weigl Color Sorting Test as an instrument to study concept formation in children. They suggested that three methods of forming concepts were indicated: (a) the concretistic or descriptive methods which characterized children's thought until age eight, (b) the functional method which reached its peak between eight and nine years, and (c) the conceptual level which appeared to be well established at age eleven. Gerstein hypothesized that these three methods used to solve a performance problem may be used in classifying definitions evoked by a verbal stimulus.

Gerstein's three level classification was defined as follows:

> (a) The concretistic or descriptive method. This represents the most primitive level of verbalized definition. It implies memory of an object at the concrete, sensory level. For example, "an apple is red." The "red" refers to a visual memory response to a concrete apple. "A donkey is a thing with four legs," represent a similiar descriptive definition.
>
> (b) The functional or usage method. This represents a more complex method of verbalizing a definition. A word is defined by the subject recalling the use to which that object was put in the past, e.g. "an apple is something you eat," or "a donkey is something you ride on."
>
> (c) The categorical or conceptual method. This represents the abstract method of definition. A concept involves an "abstract" attitude on the part of the subject . . . . "An apple is a fruit" is a conceptual definition whose modus operandi is more complex than the descriptive or functional methods (p. 368).

Gerstein cautioned against the too ready placement of a definition at the categorical level.

Later studies conducted by Stacy and Portnoy (1950) and Stacey and Spanier (1954) between 1950 and 1954 attempted to investigate Gerstein's hypothesis. In two experiments, Stacey and Portnoy (1950a,1950b)

analyzed the definitions of mental defective and borderline children and moron, borderline and dull-normal adults. Stacey and Spanier (1954) analyzed the definitions of college students to the vocabulary subtest of the Wechsler Intelligence Scale. The results of these experiments varied, but in general ran counter, at least in part, to Gerstein's hypothesis. This may have been the result of small, abnormal samples used in most of the research.

Educational researchers have adapted both the classification system of Feifel and Lorge and that of Gerstein for use in research. The system developed by Feifel and Lorge (1950) has been the basis of three investigations of vocabulary knowledge. Two studies used the multiple-choice format to investigate which level of definition subjects would choose when presented with a variety of definitions of varying degrees of conceptual goodness. Kruglov (1953) used a multiple-choice test in grades three, five, seven, and eight and with college students. She found that:

> The results of the multiple-choice, recognition type test agree with those of the recall type test for the synonym, use and description, and repetition-illustration-inferior explanation type of responses when analysis is similiar for the two tests (p. 241).

Russell and Saadeh (1962) constructed a multiple-choice test in which a functional definition, a concrete definition, an abstract definition and an incorrect definition were presented to the subject for each word. The results of the test, given to 257 pupils of grades three, six and nine, revealed a dominance of concrete-functional choices by the third grade children which declined considerably in grades six and nine, and a gradual increase in the number of functional and abstract choices

in the sixth and ninth grades. They also concluded that the number of incorrect guesses decreased steadily and that certain words, such as "experience" and "farmer", lent themselves to abstract or functional meanings.

A 1964 study by Grant (1965) extended the use of the Feifel and Lorge scale to an analysis of the vocabulary responses of thirty pairs of good and poor readers in grade six, matched on the basis of sex, intelligence quotient and chronological age. While assuming that an analysis of vocabulary responses would yield useful data concerning the child's concept development, the study investigated the general hypothesis that the ability to define words abstractly had developed more slowly in a group of poor readers than in a matched group of good readers. Grant concluded that:

> The results suggest that the good readers in the sample tend to conceptualize on more complex levels than do a matched group of poor readers. The poor readers tend to perceive more words as concrete ideas and to generalize less from the particular (p. 93).

A study by Chase (1961) attempted to test the applicability of Gerstein's three-level technique of classification to the measurement of the vocabulary of arithmetic. A multiple-choice test consisting of a stimulus word and four definitions for each word -- one defining the term with a concrete example, one definition representing a functional or usage type, a third on an abstract or conceptual level and a distractor--was administered to 141 sixth grade pupils. Students were classified into one of three groups on the basis of the response type from which they made a plurality of their choices. It was found that children showing a preference for a given level of response evidenced a corresponding

degree of achievement on outside measures of concepts in arithmetic, with the group that chose abstract definitions achieving the highest scores. Chase concluded that the three-level technique of classification could be of value in measuring the status of children's concepts associated with terms specific to an academic area.

Summary

The results of these studies indicate a gradual development in the type or quality of definition children give or choose for words. In general this development may be characterized as progessing from the specific, functional and concrete to the abstract, generic, and context-free. Later development is indicative of an abstract-symbolic attitude towards language. Since the relationship between the use of language and the underlying cognitive process is stressed in most of the studies, this development in the use of language is thought to be a reflection of changes in the child's conceptual systems. These changes in the use of language have been characterized as having certain distinguishable traits at certain stages.

A small number of studies have indicated that the qualitative levels of vocabulary responses of individuals may be related to school success in reading and arithmetic. This may be so since the quality of verbal response reflects the complexity of the underlying conceptual organization. The relationship between knowledge of various types of vocabulary has not, however, been investigated. In general, the results of an analysis of the meanings given to a general vocabulary test are assumed to be true for all varieties of vocabulary.

III. CONCEPT FORMATION AND READING

It would appear that interest in the relationship between concept formation and reading is a relatively recent development. While a number of studies have yielded significant results, these have taken place since 1950. Russell (1965) and Stauffer (1965) have recently reviewed the research in this area.

A study by Jay (1950) attempted to answer the question, "What is the fewest number of reading tasks which will describe completely a child's performance at the fourth grade level?" While eliminating tasks involving what can be done with what is read, Jay administered a battery of thirty-four reading tests and a spelling test to two-hundred grade four students.

An earlier study by the Thurstones (1941) at the grade eight level had yielded a factor, labelled X3, which, while verbal in nature, could not be definitely interpreted. Jay hypothesized that this factor was in fact a reading factor. A factorial analysis of the data indicated six specific factors and a general reading factor, identified as X3. This general reading factor required the ability to classify and Jay concluded that classifying words may be an important task in reading. Evidence from the data suggested that some children could read the words but had trouble classifying them in proportion to their decreasing reading scores.

A study by Bond and Fay (1950) compared the performance of good and poor readers on the individual items of the Stanford-Binet Intelligence Test, Form L and M. They concluded only that good readers performed

significantly better than poor readers on those items which were dependent upon the knowledge and use of words, while poor readers, as a group, performed significantly better than good readers on non-verbal and memory items.

A later study by Burks and Bruce (1955) examined the characteristics of good and poor readers as disclosed by the Wechsler Intelligence Scale for Children. They examined the general hypothesis that the poor reader may be relatively weak in those parts of intelligence tests which resemble vital characteristics inherent in written language. More specifically, they stated:

> A hypothesis was made that the poor readers, as a group, approach learning situations in a more concrete manner as a result of an inability to handle abstractions. Since the reading process inherently consists of abstractions strongly depending on memory functions, these children are handicapped. The good readers, on the other hand, do not show this lack of ability to use abstractions and have much more retentive ability (p. 493).

Burks and Bruce studied the results of eleven good readers--one or more years above the grade level on the reading section of the Wide-Range Achievement Test and thirty-one poor readers-- one or more years below the grade level on the same test. The subjects ranged from grades three to eight and had intelligence quotients above ninety.

The results of the study indicated that poor readers were high in sub-tests, such as Block Design, which involved a relative lack of need for long or short term symbolic memories and the immediate availability of a structured stimulus. Conversely poor readers were significantly lower on sub-tests, such as Coding, which involved the importance of memory functions and a given stimulus that did not remain

immediately avaliable. Burks and Bruce concluded that poor readers, as a group, approached the learning situation in a more concrete manner as a result of an inability to handle abstractions while good readers did not lack this ability and dealt with learning situations in a more abstract manner. The researchers defined concrete and abstract manner as follows:

> a person is dealing with his world in a concrete manner when he reacts to stimuli in his environment directly, without reflection, conceptualizing or symbolizing. A person reacts in an abstract manner when he mentally leaves the immediate stimuli and with the use of symbols as a tool, forms concepts and generalizations about the experience (p.490).

Since the reading process "inherently consists of abstractions strongly based on memory functions" (p. 493), Burks and Bruce considered children who operated in a concrete manner to be handicapped in the reading situation.

Kress (1956) studied the relationship between concept formation ability and achievement in reading with a sample of twenty-five pairs of males between the ages of 8-0 to 11-11 matched for chronological age, school experience and intelligence quotient. One member of the pair was classified as a retarded reader and one as an achieving reader based on informal word recognition and reading comprehension tests together with the reading sub-tests of the Stanford Achievement Tests, Elementary Battery, Form J. Six tests were administered to measure concept formation ability in the subjects. Kress concluded that retarded readers tended to lack adequate labels for common concepts and adequate concepts for dealing with language. They also exhibited a tendency to be more concrete and less abstract in conceptual functioning. A later investigation by Jan-Tausch (1960) studied concrete thinking as a factor in reading retardation. Using selected items from the Goldstein-Scheerer battery of

abstract and concrete thinking tests, together with the comprehension section of the California Test of Reading, Form cc, with 170 advanced and retarded readers in grades four to seven, Jan-Tausch tended to support the findings of Burks and Bruce (1955). He stated that retarded readers may be retarded because they are limited to concrete thinking, and that this relationship tended to become greater in the higher grades, but that other possible causes of reading retardation exist as well.

A study by Braun (1963), which relied heavily on the earlier work of Jay investigated the relationship between reading achievement and concept formation ability at the third, fifth, and seventh grade levels. Braun tested fifty boys at the third and fifth grade levels and thirty-nine boys at the seventh grade level using a test which consisted of twenty concepts with six cards for each concept. Each card contained four words, one of which had something in common with one word on each of the other cards. The subjects were chosen to include equal groups of under- and over-achievers. Under-achievers were defined as those students whose reading achievement was one year less than their mental age at the grade three level and two years less at the grade five level. Over-achievers were defined as those subjects whose reading achievement was higher than their mental age by one year at the grade three level and by two years at the grade five and seven levels. Braun hypothesized the following:

> 1. There is a positive relation between scores on a test of concept formation and reading achievement, as measured by the comprehension

> concept formation and reading achievement, as measured by the comprehension section of the Gates standardized reading tests, at the developmental levels represented by boys in the third, fifth and seventh grades.
>
> 2. The magnitude of the relation between concept formation and reading, as defined above, will be greater than the magnitude of the relation between reading and intelligence, as measured by the California Test of Mental Maturity in the third and fifth grades and the Primary Mental Abilities Test in the seventh grade.
>
> 3. The relation between reading and concept formation will increase significantly in magnitude with increasing age of boys.
>
> 4. Overachievers in reading will perform significantly better on a test of concept formation than will underachievers in reading (p. 675).

All were supported at the .01 level of significance except at the grade three level where Hypothesis Two did not hold true. Braun concluded that the work of Jay was supported in the finding that the reading factor is concept formation ability. The handicapped reader, of normal intelligence, represents a special population in concept formation ability for whom the use of intelligence tests as the basis for expectancy seems questionable since in these children intelligence and reading are not closely linked.

A study by Wickens (1963) investigated the ability of twenty-five matched pairs of good and poor readers in grade four to abstract. The pairs were matched on the basis of intelligence quotient. She tested the hypothesis that good readers would manifest a greater capacity to abstract, as evidenced by their performance and verbalization of categorizing principles on tests which were designed to measure abstracting ability. A large battery of tests was administered. Wickens

concluded the following:

1. Good readers can abstract better than poor readers.
2. Good readers are significantly superior to poor readers on performance tests of abstraction.
3. Good readers are significantly superior to poor readers in verbalizing the categorizing principles arising from abstraction (p.100).

The results of these recent studies seem to indicate strongly that one of the important variables in reading is the ability to handle conceptual abstractions. Reading, in part, is the communication between writer and reader of meaning through the use of abstract symbols which represent an accumulation of experiences. The above experiments seem to indicate that comprehension is partially dependent upon the abstractness of the meaning which a reader has for the symbols. In addition, the relationship between reading comprehension and the ability to handle abstract concepts appears to increase with age throughout the elementary school.

IV. VOCABULARY OF MATHEMATICS

The mathematical vocabulary of children has been often studied. The majority of these studies concern children's knowledge of written vocabulary and are more concerned with relating vocabulary knowledge to success in some aspect of mathematics than with the developmental aspects of mathematical vocabulary. As early as 1925, Lessenger (1925) concluded that there was a significant relationship between reading ability and computational ability. By 1949 Johnson (1949) was able to draw conclusions from some fifty investigations of the relationship between vocabulary knowledge and success in arithmetic. Since then more work has been done.

A study by Buckingham (1937) of the relationship between vocabulary and ability in first year algebra revealed a significant relationship between knowledge of words and ability to do algebra problems. In addition, the word definitions of the students revealed three levels of development: (a) completely undeveloped, (b) concretely developed but abstractly not completely developed, and (c) completely developed abstractly with concomitant concrete imagery, as in the case where the student defines and illustrates graphically (p. 79).

Eagle (1948) studied the relationship between various reading abilities and success in mathematics with two groups of grade nine pupils. The groups were composed of 157 mathematics students and 162 algebra students. Using a multiple-choice type of exam, he found that general vocabulary correlated with success in mathematics only .25 and with algebra .31, while mathematics vocabulary and mathematics success correlated .53 and .48. He concluded that reading comprehension and mathematics success were largely associated with mental age but that reading comprehension was still significant when mental age was parcelled out.

Johnson (1949) studied the nature of problem solving in arithmetic with grade eight pupils in Chicago. He stated that the relationship between problem solving and reading must be examined in terms of specific reading skills rather than general reading ability. From a battery of reading, arithmetic and intelligence tests, he concluded that it might be correct to say that problem solving in arithmetic is related to general intelligence through the factors of vocabulary and reasoning.

Van Engen (1953) reviewed the formation of concepts for teachers of mathematics. He stated that mathematical concepts result from numerous sensory experiences which are combined, generalized and carefully developed. The integration of the sensory experiences is accomplished by a process that is symbolic in nature. In the case of humans, words usually accomplish this integration. Certain mathematical concepts may be almost entirely abstract in nature and the sensory experiences upon which they are based are intangible making it difficult to trace the origins of the concept. Van Engen cites as an example the mathematical concept of "implication" which he states "appears to be more on insight into how words are used rather than sensory experiences" (p. 81). However, he also stresses that a verbal response is not a necessary condition for a concept and that the existence of nonverbal concepts is of utmost importance to the teacher of mathematics. He concluded by stating:

> Abstract definitional approaches should be abandoned by the elementary teacher and secondary teacher for an approach which emphasizes the organic awareness of a concept before it is characterized by a definition or designated by a symbol (p. 91).

In general these studies seem to indicate a significant relationship between reading ability, particularly vocabulary knowledge, and success in mathematics, especially problem solving. They indicate that mathematics vocabulary correlates more highly than general vocabulary with success in mathematics. The formation of mathematical concepts has been reviewed and appears to be very similiar to the formation of other types of concepts.

V. SUMMARY

The first part of this chapter reviewed briefly some of the aspects of concept formation. Part two consisted of a summary of the investigations of concepts through the analysis of verbal definitions. This was followed by a discussion of the relationship between concept formation and reading ability. The last part was concerned with a brief overview of the investigations of the vocabulary of mathematics.

The review of the research revealed that concepts play an important part in cognitive life. They represent an organized knowledge of the world around and because of this organization they are applicable to various new situations. In addition, concepts change and develop as the individual matures. One of the methods used to investigate concepts has been the analysis of vocabulary meanings. The analysis of the meanings for verbal labels has revealed much about the internal cognitive structures of the subjects.

The relationship between concept formation and reading has only recently been investigated. The abstractness of meaning attached to the verbal labels has been shown to be an important factor in reading ability.

Children's knowledge of the meanings of general or core vocabulary has been often studied. In addition, children's knowledge of the meanings of specialized vocabularies, such as that of arithmetical terms, has also been studied. However, little attention has been focused on the relationship between children's knowledge of these two types of vocabulary.

CHAPTER III

THE DESIGN OF THE STUDY

This chapter describes the design of the study. A description of the population and a discussion of the sampling plan are followed by an outline of the procedures undertaken to investigate the hypotheses. The last section deals with the construction, administration and scoring of the testing instruments.

I. INTRODUCTION

A sample of fifty students was chosen from a population of six classes of grade six pupils who attended two of the Edmonton Public Schools during the 1966-67 school year. The sample was stratified on mathematics achievement according to the percentile achieved on the most recent system-wide standardized mathematics examination written in April of 1967. There were twenty-five low achievers, who had achieved a percentile ranking of twenty-five or lower, and twenty-five high achievers, who had achieved a percentile ranking of seventy-five or better.

For each member of the sample the results of several system-wide standardized examinations were recorded from the cumulative record cards. Results were obtained for the following standardized examinations:

1) Lorge-Thorndike Intelligence Test, level 3, form A,
2) California Reading Test, form y,
3) Sequential Tests of Educational Progress (STEP), Reading Section, form 4A, and
4) Seeing Through Arithmetic Test (STAT), grade 6 level.

A sixty word test of core and specialized vocabulary was constructed by the investigator to measure the subjects' knowledge of core and specialized vocabulary. This test contained thirty core and thirty specialized words and yielded qualitative core and specialized vocabulary scores. This vocabulary test was administered by the investigator to each of the subjects individually. The words were presented visually and the student was asked to define each word orally. Each subject's responses were tape recorded and transcribed on the same day by the investigator. The responses were later typed onto sheets for purposes of grading.

All the responses for each word on the test were graded using the scale hypothesized by Gerstein (1949). In addition, the errors were analyzed using the categories derived from Feifel's (1952) study of the most common types of errors in defining a word. The number of definitions for both types of vocabulary at each level of Gerstein's scale and the total number of errors for both types of vocabulary were obtained for each subject. These scores were considered to be the qualitative vocabulary scores for each type of vocabulary for the subject.

Each of the scores obtained for the subject by these two procedures, that is,

a) transcription of the results of standardized tests from the cumulative record cards, and

b) the qualitative analysis of the subject's responses to the core and specialized vocabulary examination,

was punched onto a computer card together with the subject's coded identification number. Statistical analyses by means of 't' tests of

significance and Multiple Linear Regression were then performed.

II. POPULATION AND SAMPLE

The population for this study consisted of those students who attended grade six classes in the Edmonton Public Schools during the school year 1966-67 and who had achieved either a percentile rank of twenty-five or lower or a percentile rank of seventy-five or higher on the most recent system-wide standardized arithmetic test. The sample was chosen from this population according to the procedures outlined below. The results may be generalized to the population represented by these two extreme groups but not to the population which fell between the twenty-fifth and seventy-fifth percentiles.

The sample was obtained according to the following procedure. The investigator was given permission to test students in two of the Edmonton public elementary schools containing six grade six classes. The results of the most recent STAT mathematics examination were recorded for each pupil and converted into a percentile score where necessary. Lists were compiled of all students who obtained a percentile rank of seventy-five or greater and twenty-five or lower on the STAT examination. The cumulative record cards of these students were examined and all eliminated from the sample who had incomplete record cards or had come to Edmonton during the preceding two years. Each of the remaining students was assigned a number.

The final selection of the sample was done through the use of a table of random numbers. This procedure yielded a stratified sample composed of fifty grade six students, twenty-five of whom had achieved

a percentile rank of seventy-five or better on a standardized arithmetic exam and twenty-five who achieved a percentile rank of twenty-five or lower. All members of the sample attended two of the Edmonton public schools during the 1966-67 school year and had taken the new mathematics program for at least two years.

The results for each member of the sample on the Lorge-Thorndike Intelligence Test, level 3, form A, the California Reading Test, form Y, and the STEP, reading section, form 4 A were compiled, together with the subject's age in months and his sex. Statistical analysis by means of a "t" test of the significance of the difference between the means of the high group of achievers in arithmetic and the low group of achievers in arithmetic for each of the above mentioned variables is summarized in Chart I. The results indicated that the two groups differed significantly, beyond the .01 level of significance, in terms of age, verbal and non-verbal intelligence quotients, and both standardized reading test scores, but did not differ significantly in terms of sex. The resulting sample was composed, therefore, of a stratified sample that differed significantly on the following variables;

1) score achieved on the Grade 6 Seeing Through Arithmetic Test,
2) score achieved on the California Reading Test, form Y,
3) score achieved on the STEP, reading section, form 4A,
4) verbal and non-verbal intelligence quotient achieved on the Lorge-Thorndike Intelligence Test, level 3, form A, and
5) age

The sample, therefore, may only be generalized to a population that is represented by these two extreme groups.

TABLE I

HIGH AND LOW GROUPS COMPARED ON SELECTED CRITERIA BY MEANS OF "t" TESTS

Variable	High Achievers Mean	High Achievers S.D.	Low Achievers Mean	Low Achievers S.D.	t	p
C.A. in months	140.92	3.33	149.68	7.78	5.070**	.00000
Verbal I.Q.	129.08	20.82	96.44	10.43	6.868**	.00000
Non-Verbal I.Q.	116.40	12.01	101.68	11.88	4.269**	.00000
California Reading	109.76	5.72	84.00	15.28	7.737**	.00000
STEP Reading	56.52	7.16	43.44	11.81	4.639**	.00001
Sex (a) males	.48	.50	.64	.50	1.131	.26351
(b) females	.52	.48	.36	.48	1.131	.26351

* Significant $p < .05$
** Significant $p < .01$

III. PROCEDURE

The sample was selected to obtain a stratified sample consisting of a high and a low group of achievers in mathematics, as defined in this study. An analysis of the results of standardized reading and intelligence tests revealed a stratified sample that differed significantly not only in terms of achievement in mathematics but also in I.Q. score, both verbal and non-verbal, and on two measures of achievement in reading. In addition to recording data from the cumulative record card for each child, each subject was given an individual vocabulary test designed specially for this study to measure core and specialized vocabulary. The results were analyzed according to Gerstein's (1949) scale. The following procedures were then undertaken to investigate each of the hypotheses.

In order to test Hypothesis 1, the results of the vocabulary test designed specifically for this study were qualitatively analyzed and scores were derived for each subject for each of the three levels of correct responses and the error category for both core and specialized vocabulary. The mean score for each level of correct responses and for the error category was obtained for both groups for core and specialized vocabulary. A "t" test of the significance of the difference between the means for core and specialized vocabulary at each level and the error category was computed for both groups.

To test Hypothesis 2 a comparison was made between the mean for the high group of achievers in mathematics and the mean for the low group of achievers in mathematics at each level of response and for the error category for the specialized vocabulary by means of "t" tests.

Hypothesis 3, for reading achievement, was tested in a similár fashion. A comparison was made of the means for the high group in reading with the mean for the low group in reading at each level of response and for the error category for core vocabulary by means of "t" tests.

To test Hypothesis 4, the results of the Lorge-Thorndike Intelligence Test, level 3, form A, verbal and non-verbal sections, were recorded for each subject. Multiple Linear Regression models were written which used the verbal and non-verbal intelligence quotients separately as predictors of the qualitative vocabulary scores of the subjects for both core and specialized vocabulary.

Hypotheses 5 and 6 were tested in a similar manner. In the case of Hypothesis 5, the sex of the subject was used as a predictor of the qualitative vocabulary score, and in the case of Hypothesis 6, the subject's age in months was used as a predictor.

In order to answer the two questions pertaining to the error category, all responses marked as errors were re-analyzed and placed in one of Feifel's categories of most common errors. Tables were then prepared comparing the numbers of errors in each error category for core and specialized vocabulary for both groups. In this way a comparison of the quantity and distribution of errors was made possible.

IV. INSTRUMENTATION

As a regular part of a system-wide testing program, the following tests were administered to all grade six students attending the Edmonton Public Schools during the 1966-67 school year: (a) The Lorge-Thorndike Intelligence Test, level 3, Form A, (b) The California Reading Test, Form Y,

(c) the Sequential Tests of Educational Progress (STEP), Reading Section, Form 4A, and (d) the Seeing Though Arithmetic Test to accompany the Grade 6 program. Results of each of these tests were recorded from the cumulative record card of each subject. An analysis of the tests, test manuals, and critical reviews revealed the following information concerning each of the tests.

Lorge-Thorndike Intelligence Test

This test purports to measure "abstract intelligence" defined as the "Ability to work with ideas and relationships among ideas" (Burns, 1959, p. 350). The test is intended to sample the following cognitive tasks: (a) dealing with abstract and general concepts, (b) interpretation and use of symbols, (c) dealing with relationships among concepts, (d) flexibility in the organization of concepts and symbols, (e) utilizing one's experience in new patterns, and (f) utilizing "power" rather than "speed" in working with abstract materials. Norms were standardized on a population of 136,000 in forty-four communities in twenty-two states. Little information is given concerning the nature of the sample. Odd-even reliability scores were between .88 and .94. Validity studies, although meager, indicated positive correlations between the results on this test and school achievement. A correlation of .67 was reported between the test score on the Lorge-Thorndike and the average achievement of 214 grade nine pupils. A correlation of .87 was reported between the results of the Lorge-Thorndike, and the grade equivalents in reading of the Stanford Achievement Tests. The level 3, form A test is one of several levels and forms and is designed to be used in

grades 4 to six. Most reviewers tended to agree with Freeman that this test "is among the best group tests available, from the point of view of the psychological constructs upon which it is based and that of statistical standardization" (Buros, 1959, p. 350).

California Reading Test

This test consists of a fifty word multiple-choice vocabulary test and seventy multiple-choice comprehension questions. In all cases there are three distractors and a correct response. The vocabulary section is divided into a general and three specialized vocabularies. It is stated in the manual that analysis of the reading test results would reveal strengths and weaknesses in several general areas. Among these are following specific instructions, finding sources and doing reference work, comprehending factual material and drawing valid conclusions from materials read (Tiegs and Clark, 1957, p. 32). Reliability coefficients were computed using the Kuder-Richardson formula 21 and yielded coefficients for the reading vocabulary and comprehension sections of .91 separately and .95 together. The standard error of measurement is given as 10.8 and 13.1 for the reading vocabulary and comprehension sections respectively. Construct validity was measured by correlation of the test results with those of a measure of mental maturity and school achievement. The correlation between this reading test and the California Test of Mental Maturity at the grade five level with two-hundred subjects was .75 and .70 with the verbal and non-verbal mental age scores respectively. Correlation at the grade five level with ninety-nine subjects of the reading vocabulary section

of the Metropolitan Achievement Tests, Elementary Form R, was reported as .95 and with the vocabulary section of the Stanford Achievement Test, Intermediate, Form J, as .83, with 128 grade five subjects. Coefficients of correlation with the comprehension sections of the same tests and with the same samples were given as .83 and .85. It was the opinion of reviewers that this test is a valuable tool in measuring important vocabulary and comprehension skills but that further reliability and validity studies would be valuable.

Sequential Tests of Educational Progress (STEP) Reading Test

This test consists of fourteen comprehension passages with five multiple choice questions on each. It purports to measure five major comprehension skills: ability to recall ideas, ability to translate ideas and make inferences, ability to analyze motivation of the author, ability to analyze presentation, and ability to criticize. The test was analyzed for internal reliability, which yielded a median reliability coefficient of .915, but was not submitted to any outside measure of reliability. Little statistical information is given about validity. The publishers state that content validity is best insured by relying on well-qualified persons in constructing the test, which they feel was done for the STEP series. Reviewers, such as Betts (Buros, 1965, p. 810) have stated that this is a carefully constructed reading test, but have noted the lack of research evidence of validity and reliability.

Seeing Through Arithmetic (STA) Test

This multiple-choice examination is designed to test all aspects of pupil's competence in arithmetic. It is divided into six sections as follows:

Part 1 Problem Solving - emphasis on thinking through a problem rather than computation

Part 2 Computation - computational ability

Part 3 Problem Solving: selecting equations - ability to select equations that show the structure of the problem

Part 4 Problem Solving: solving equations - ability to find numerical replacement for the place holder.

Part 5 Information - mastery of certain arithmetic information eg. 1 yard = 36 inches.

Part 6 Concepts - requires careful thought and understanding of certain arithmetic principles rather than recall of information or computation

The norms for the test were derived from a sample of approximately 50,000 pupils in over 1,000 schools including both users and non-users of the publisher's arithmetic series. In addition, the publisher provides yearly norms based on a collation of nationwide test results. No information is given about the sample. In addition, no validity or reliability studies are reported. However, an expert reviewer concluded:

> that these tests reflect expert skill in test construction, and that they should facilitate more effective measurement of mathematical behaviour of elementary school pupils (Buros, 1965 p. 637).

Administration of Group Tests

The standardized tests, administered as part of a system-wide testing program were written by all pupils throughout the system at the same time. The Lorge-Thorndike Intelligence Test and the STEP Reading Test were administered in February, 1967, while the California

Reading Test and the STA Test were written in April, 1967. Each of these tests was administered and scored according to the instructions set down in the test manual. Results were recorded on the cumulative record card of each student.

V. CONSTRUCTION, ADMINISTRATION AND SCORING OF THE VOCABULARY TEST

In addition to the group tests described previously, each subject was given a sixty-word vocabulary test of core and specialized words constructed specifically for this study by the investigator. This test was designed to measure the child's knowledge of core and specialized vocabularies, as they are defined in this study. It was composed of thirty core words and thirty specialized words from the field of mathematics. The test was constructed according to the following procedures.

Construction of the Vocabulary Test

The mathematics series Seeing Through Arithmetic (Hartung et al, 1958) is authorized by the Department of Education for use in Alberta and is the series used in the Edmonton Public Schools. Thus, the specialized mathematical words contained in this series represented the minimum body of specialized words which pupils must know to read in the field of mathematics at school. So the specialized words were selected from this series according to the following procedures.

1. Each book at the grade four, five and six level was reviewed and all new words were listed. A new word was one which had not been introduced in the previous grade. All mathematical terms on the list,

that is, words which would be used primarily for communication in the field of mathematics, were marked. The context in which each of these words appeared in the book was checked to ensure usage as a mathematical term. As much as possible, words were eliminated which had a familiar meaning that was not mathematical. This yielded a total list of 151 words: forty-five, fifty-eight, and forty-eight words at the grade four, five and six levels respectively.

2. It was decided that thirty specialized words should be included in the test. The vocabulary sections of the Stanford-Binet and WISC Intelligence Tests contain forty-five and forty words respectively, therefore, it was felt that thirty words yielded a significant sample of the subject's knowledge of specialized vocabulary. Each word on the specialized list was assigned a number. Using a table of random numbers, a total of thirty words was chosen. The resulting distribution was seven, thirteen, and ten words from the grade four, five and six levels respectively.

In selecting the thirty core vocabulary words, it was decided to use words from vocabulary tests which were designed to measure core or general vocabulary and which had proven themselves over a period of time. As a result, the following steps were taken:

3. The first sixteen words up to the beginning of the age fourteen level were selected from the Stanford-Binet Vocabulary Test.

4. All the words from the California Achievement Tests, Complete Battery, form X, Elementary level, general vocabulary section were chosen. There are thirteen words in this test.

5. One additional word was chosen randomly from the WISC Vocabulary

Test to make a total of thirty core words.

6. Each of the resulting thirty core and thirty specialized words was assigned a number and a table of random numbers was used to decide the order of presentation of these sixty words on the test.

7. Typed copies of the finished test were prepared.

8. Instructions were determined for administration of the test according to the Manual for the Third Revision (1960) for the Stanford-Binet Vocabulary Test. These instructions have been proven successful. Each subject was asked to tell in his own words what each of the words on the test meant. He was allowed to give as many meanings as he liked or to explain the meanings at any length he desired. Each subject was encouraged to respond in some way to each word through the use of neutral questions such as "Fine, could you tell me a little more.".

Administration of the Vocabulary Test

The sixty-word vocabulary test of core and specialized vocabulary was administered in June of 1967, in both schools. All testing was done by the investigator according to the instructions described previously. Students were tested individually in a small quiet room free of excess distractions. The subject's oral definitions were recorded on tape and transcribed by the investigator on the same day. The responses were then typed onto sheets for purposes of qualitative analysis. This analysis yielded a qualitative score for core and specialized vocabulary for each subject.

Qualitative Scoring of the Vocabulary Test

As stated previously, qualitative analysis was carried out according

to Gerstein's (1949) classification system. A correct definition may be given by one of three different methods: the concretistic or descriptive method, the functional or usage method, and the categorical or conceptual method. A description of these categories will be given later.

In addition, errors were categorized according to Feifel's (1952) classification system for errors. The error categories were as follows:

1. incorrect demonstration: A wrong designation is made by gesture, e.g. "eyelash" - the students point to the eyebrow.

2. misinterpretation: The student defines a substitute word which is physically similar to the stimulus word, eg. "haste" - "you don't like that boy", "liters" - "Baby kittens."

3. wrong definition: The student is mistaken in his concept of the word, e.g., "triangle" - "a square"

4. clang association: The response is a word which has a sound similar to the word to be defined, e.g. "puddle" - "paddle".

5. repetition without explanation: The stimulus may be repeated alone or accompanied by one or more words or phrases, but the definition gives no indication that the subject knows the meaning of the word, e. g. "pair" - "a pair of something".

6. omission: The subject either makes no reply or states that he does not know the meaning of the word.

Qualitative scoring was carried out according to the following procedure. The oral definitions given by the subjects were transcribed and given a code number for identification purposes. Each definition given by the fifty subjects to one of the stimulus words was classified according to Gerstein's scale or as an error. All errors were then classified according to Feifel's error categories. The total number of definitions

at each of the three levels and the error category for both core and specialized vocabulary were tallied for each subject and these scores were considered to be the subject's qualitative vocabulary scores.

VI. DESCRIPTION AND MODIFICATION OF GERSTEIN'S SCALE

As a result of a preliminary study of inter-scorer reliability using the Gerstein scale, a number of changes were made in the scale. The changes are outlined below together with a description of the resulting classification system.

An inter-scorer reliability study was undertaken using two independent scorers trained in the field or reading. The results indicated considerable agreement among the scorers, but there was still the need to clarify the criteria for the three levels in order to lessen the possibility of varying interpretations of Gerstein's scale. As a result of a meeting held with the two scorers and the investigator, two drawbacks were found to exist in the Gerstein scale as it had been set forth:

a) the explanation and examples given did not fully define the three categories, and

b) the scale did not consider the logical quality of the definition.

These two drawbacks were considered to be undesirable. The lack of definition of the three categories made scoring the responses more subjective than was desirable. Overlooking the logical quality of the definition meant that the verbal control which the subject had over the concept was ignored. To remedy both of these faults, the scale was modified by describing the types of logical definitions which

corresponded to each of the three methods of definition. In this way it was hoped to make the scale more explicit and to allow analysis of the logical quality of the definitions. The resulting scale may be found in Tables II, III and IV.

Gerstein's categorization of the method of definition is in terms of the psychological qualities of the concept possessed by the subject. In general, the scale progresses from the concrete and sensory to the abstract and generic. The logical analysis of definitions is in terms of the nature and degree of verbal control of the concept which the subject possesses. The ideal logical method of definition is to "state the connotation by successively dividing an inclusive genus into progressively narrower subspecies" (Black, 1954, p. 24). Definitions by classification most nearly reaches this ideal. Lesser types of definition, such as the denotative method, merely give a concrete example of the term. Rather than classifying the concept in terms of another genus, they merely give an exemplar of the term. It should be noted that not all words may be defined in terms of genus and differentia (Robinson, 1954, p. 97). The logical types of definition were taken from Black (1954), Ennis (1964), and Robinson (1954).

The resulting scale, as presented in Tables II, III, and IV gives a description of each of Gerstein's methods of definition together with the logical types of definition which most often occurred in that method. Thus, the scale is an attempt to collate the logical and psychological criteria of the process of definition. While the psychological, as represented by Gerstein's categories, classifies the type of concept which the child possesses for a term, the logical assesses the learned

TABLE II

GERSTEIN	MODIFICATIONS Type	Description	Example
Descriptive: memory of an object at the concrete, sensory level.	1. Ostensive method:	1. gesture: or use of words like "Here is a . . ".	1. "Here is a puddle."
	2. Denotative method	2. specific, concrete examplar of the concepts.	2. "puddle"- is some water on the ground."
	3. Implicative method	3. use of the word in a sentence as a concrete example.	3. "east"-Montreal is east of here."
	4. Range definition	4. a list of characteristics, most of which apply when the term applies.	4. "puddle"-"water": "mud": "wet".
	5. Method of synthesis:	5. indicates a particular by mentioning one of its unique relations to another particular.	5. "kilogram"-"one-thousand times a gram."
	6. Different only:	6. indicates characteristic(s) which differentiates term, but no general class.	6. "triangle"-"it has three corners."

TABLE III

GERSTEIN	MODIFICATIONS Type	Description	Example
Functional: subject recalls use to which object was put in the past, or function of concept.	1. Manipulation operational definition:	1. specific examples of use of the concept.	1. "straw"-"used for feeding horses and cattle."
	2. Implicative method:	2. use of word in a sentence expressing usage of the concept.	2. "calendar"-"He looked at the calendar to find the date."
	3. "if-clause" method:	3. subject gives and "if-clause" operation and relationship between concept and resulting observation.	3. "puddle"-"if it rained all night, the water left on the street would be puddles."
	4. Set of operations definition:	4. subject explains function of the concept.	4. "calendar"-"a thing to keep track of the days."

TABLE IV

GERSTEIN		MODIFICATIONS	
	Type	Description	Example
Categorical: abstract method of definition in terms of class.	1. Synonym definition: a) modified b) unmodified	1. a) subject gives a word as equivalent as possible, with a modifier indicating the difference between terms.	a) "lecture" - "a learned speech."
		b) a word as equivalent as possible only.	b) "altitude" - "height."
	2. Genus only:	2. subject gives general class for term but no differentia.	2. "triangle" - "a figure."
	3. Definition through classification:	3. subject gives a general class and a distinctive feature or features on particular term.	3. "triangle" - "a plane figure having three sides."

verbal control the subject has over the concept. The resulting scale was checked for its validity by a person trained in reading and with considerable experiences in analyzing definitions.

VII. RELIABILITY OF SCORING

The reliability of classification of responses given to the vocabulary test was established through inter-scorer agreement. Ten percent of the words, randomly selected, were rescored by an independent scorer trained in the field of reading. The scoring principles, in the form of the tables presented earlier, were made available to the scorer. No information was given about the original ratings of the definitions by the investigator.

The percentage of agreement between scorers was computed by using the Arrington formula as quoted in the study by Feifel and Lorge (1950). Accordingly, the responses in each observer's scoring that agreed with the others (i.e. doubling the agreements) was divided by this total plus the disagreements or 2 x agreements /(2 x agreements) + disagreements.

The percentage of agreement ranged from .85 to .95 for each word rescored. Therefore, the reliability of the qualitative scoring in this study is satisfactory.

VIII. TREATMENT OF THE DATA

All the data gathered for each subject were copied onto a master sheet and later punched onto a computer card. Each subject was represented by a separate card which contained the following measures:

1) Individual's coded identification number.

2) Number of core definitions at the Descriptive level.

3) Number of core definitions at the Functional level.

4) Number of core definitions at the Conceptual level.

5) Number of core definitions in the Error category.

6) Number of specialized definitions at the Descriptive level.

7) Number of specialized definitions at the Functional level.

8) Number of specialized definitions at the Conceptual level.

9) Number of specialized definitions in the Error Category.

10) Subject's score on the verbal section of the <u>Lorge-Thorndike Intelligence Test</u>, level 3, form A.

11) Subject's score on the non-verbal section of the <u>Lorge-Thorndike Intelligence Test</u>, level 3, form A.

12) Subject's score on the <u>STEP Reading Test,</u> form 4A.

13) Subject's score on the <u>California Reading Test,</u> form Y.

14) Indication of subject's sex.

15) Indication of subject's membership in either the group of high or low achievers in mathematics.

These data were analyzed as follows. Means and Standard Deviation were computed for each variable and correlation coefficients were calculated for all pairs of variables. Further statistical analysis was carried out by means of "t" tests and Multiple Linear Regression.

IX. SUMMARY

In this chapter a description of the procedures used in the project was presented. The sample was described and the standardized testing instruments were reviewed. The method of construction of the vocabulary

test was specified. A description of the scoring procedures was followed by a brief outline of the statistical treatment of the data.

CHAPTER IV

ANALYSIS OF THE DATA

The purpose of this chapter is to present the findings of the study. A review of the characteristics of the sample is followed by a discussion of the characteristics of the pupil responses and an analysis of the frequency of responses in each category for first core and then specialized vocabulary. A comparison of the responses given to core and specialized vocabulary by first the high and then the low group precedes an analysis of the errors given in response to core and specialized vocabulary. An analysis of the relationship between the qualitative level of definition given to core and specialized vocabulary and sex, reading test score, intelligence quotient and age is followed by a brief analysis of the logical quality of the definitions.

All statistical analysis was done at the Division of Educational Research, Faculty of Education, University of Alberta.

I. CHARACTERISTICS OF THE SAMPLE

The sample was composed of fifty grade six students who were attending two of the Edmonton public schools during the school year 1966-67 and who had taken the new mathematics program for at least two years. Twenty-five of the subjects had achieved a percentile rank of seventy-five or better on the Seeing Through Arithmetic Test (STAT), grade six level, and twenty-five had achieved a percentile rank of twenty-five or lower. Thus, the sample was selected to represent high and low groups of achievers in terms of mathematics.

The results of an anaysis of the significance of the difference for the high and low groups on the Lorge-Thorndike Intelligence Test, the California Reading Test, the STEP, reading sections, as well as age and sex have been

presented in Chapter III Table I. These results indicated that the groups differed significantly, at the .05 level, on each of these variables with the exception of sex.

The sample was composed therefore, of two groups, a high and a low group, which differed significantly on all of the variables analyzed with the exception of sex. The results of the analysis of the qualitative vocabulary scores will be presented in terms of two separate groups. Where the two groups were put together for purposes of analysis, group membership was controlled statistically by holding it constant. This was done when an analysis of the relationship between the qualitative level of core and specialized vocabulary and age, sex, intelligence quotient and reading score was undertaken.

II. CHARACTERISTICS OF PUPIL RESPONSES

The subject's responses to the vocabulary test were analyzed according to the three-level scale hypothesized by Gerstein (1949). According to this scale, correct responses may be one of three types, Descriptive, Functional and Conceptual. Incorrect responses were placed in the Error category. The general characteristics of the subject's responses will be described briefly.

Table V shows the frequency of definitions in each of the categories for core and specialized vocabulary. As this table indicates, no type of definition was exclusive to either group or either type of vocabulary. However, there are considerable differences in the number of responses in each category for the two groups and the two types of vocabulary. For example, the high group made almost two-and-a-half times as many errors for specialized words as for core words.

TABLE V

FREQUENCIES OF DEFINITIONS IN EACH CATEGORY FOR CORE AND SPECIALIZED VOCABULARY

Category	Core		Specialized	
	High Gp.	Low Gp.	High Gp.	Low. Gp.
Descriptive	116	166	143	205
Functional	243	224	93	81
Conceptual	318	155	338	181
Error	73	205	176	283

During the analysis of the definitions given by both groups to both types of vocabulary, the investigator observed three general features of the definitions:

a) Tendency towards one-word definitions.

b) Use of repetition without sufficient explanation as a means of defining.

c) Definition without regard for the part of speech of the stimulus word.

The investigator concluded from the above observations that many of the definitions were of poor quality and of such a nature as to suggest that at least part of the subjects' difficulty could be due to a lack of training and practice in expressing and manipulating verbal concepts.

The tendency to define a word by giving one other word, as illustrated by definitions such as "scorch" - "hot", "temperature"- "degree", would seem to indicate a faulty conception of the logical demands of the process of definition on the part of the person defining. A definition must classify the stimulus word while differentiating it from dissimilar concepts. The one-word definition did not do this. In a similar manner, definitions which repeated the stimulus word without sufficient explanation, e.g. "pair" - "a pair of something", "temperature" - "like the temperature outside", indicated a lack of knowledge of the logical necessities of the process of definition.

Definitions often ignored the part of speech of the stimulus word. "Skill" was often defined as "skillful" and "divisor" as "divide".

Ignoring the part of speech of the stimulus word resulted in imprecise definition, e.g. "juggle" - "when a man throws something up in the air and catches it." This lowered the quality of the definition.

There was a strong tendency for certain words to lend themselves to certain types of definitions. Sixteen of the sixty words on the vocabulary test failed to elicit a definition at one of the three levels. Three of the words elicited correct definitions at only one of the three levels. These findings agree with the research of Feifel and Lorge (1950) which concluded that not all stimulus words provided equal opportunity for all types of responses. Examples of words with this tendency included "pictograph" which did not elicit any functional definitions, "devout" which did not elicit any descriptive definitions, and "forbid" which was never given a conceptual definition.

III. ANALYSIS OF THE FREQUENCY OF THE RESPONSES GIVEN TO A CORE VOCABULARY

All responses given by each subject were categorized according to the three level scale hypothesized by Gerstein (1949) and described previously. Qualitative vocabulary scores were obtained by tallying the number of definitions in each category for both core and specialized vocabularies for each subject. The mean number and the standard deviation for each category of definition given in responses to a core vocabulary by a high group of achievers were calculated. The results are presented in Table VI. The results of similar analysis for the responses given by the low group are presented in Table VII.

TABLE VI

COMPARISON OF THE MEAN NUMBER OF RESPONSES GIVEN BY THE HIGH GROUP IN EACH CATEGORY OF DEFINITION

Qualitative Category	Core		Specialized			
	Mean	S.D.	Mean	S.D.	t	p
Descriptive	4.64	2.57	5.72	1.73	2.57*	0.02
Functional	9.72	3.34	3.72	1.76	9.95**	0.00
Conceptual	12.72	3.53	13.52	2.58	1.19	0.24
Error	2.92	1.65	7.04	2.46	8.57**	0.00

* Significant $p<.05$
**Significant $p<.01$

TABLE VII

COMPARISON OF THE MEAN NUMBER OF RESPONSES GIVEN BY THE LOW GROUP IN EACH CATEGORY OF DEFINITION

Qualitative Category	Core		Specialized			
	Mean	S.D.	Mean	S.D.	t	p
Descriptive	6.64	3.14	8.20	3.41	2.32*	0.03
Functional	8.96	3.28	3.24	2.32	9.10**	0.00
Conceptual	6.20	4.06	7.24	3.42	1.41	0.17
Error	8.20	3.57	11.32	3.21	4.51**	0.00

* Significant $p < .05$
** Significant $p < .01$

High Group

The mean number of definitions in each category, as presented in Table VI, indicate that the high group defined core words most often at the conceptual level. There were many definitions at the functional level and the fewest correct definitions at the descriptive level. Thus, there was a gradual increase in the mean number of definitions given to core vocabulary by a high group of achievers through the categories from descriptive to conceptual. There were few errors.

The finding that the high group exhibited a preponderance of definitions at the conceptual or categorical level agrees with the hypothesis of Gerstein (1949) that the conceptual level of definition is well established by age eleven. In addition, this finding is in agreement with the results of research by Russell and Saadeh (1962) which revealed a preponderance of abstract and functional choices at the grade six level.

Low Group

The mean number of definitions in each category presented in Table VII indicate that the low group defined core words most often at the functional level. The remaining correct definitions are almost evenly divided between the descriptive and the conceptual type of definition with slightly more descriptive definitions. There were many errors. The finding that the majority of the definitions given by a low group to core vocabulary are of the functional and conceptual types is in general agreement with the hypotheses of Gerstein (1949) and the results of research by Russell and Saadeh (1962).

Summary

An inspection of the mean number of responses at each level of

definition given by both groups in response to core vocabulary revealed a preponderance of conceptual and functional definitions. This finding is in agreement with the hypothesis of Gerstein (1949) that the conceptual type of definition is well established by age eleven. In addition, the research of Russell and Saadeh (1962) also indicated a majority of the definitions at the functional-conceptual level for grade six students.

The gradual increase in the mean number of responses through the categories from descriptive to conceptual exhibited by the high group suggests a wave of development in agreement with that hypothesized by Gerstein. The low group did not exhibit this pattern. Their greatest frequency of response was in the functional category. This may be suggestive of a pattern of development which is slower but will ultimately result in a majority of responses at the conceptual level.

IV. ANALYSIS OF THE FREQUENCY OF RESPONSES GIVEN TO A SPECIALIZED VOCABULARY

After all the responses were categorized according to Gerstein's scale, the mean number and standard diviation for each level of definition was calculated for both groups and for both types of vocabulary. The results for the high group when defining specialized words are presented in Table VI while those for the low group are presented in Table VII.

High Group

The mean number of definitions in each category as presented in Table VI, indicates that the high group defined specialized words most often at the conceptual level. There were many definitions at the descriptive level and fewest correct definitions at the functional level.

There was a considerable number of errors.

The finding that the conceptual type of definition was most frequent tends to agree with the hypothesis of Gerstein (1949) that the conceptual type of definition is well established by age eleven.

Low Group

The mean number of definitions in each category, as presented in Table VII, indicate that the low group defined specialized words most often at the descriptive level. There were considerable definitions at the conceptual level and fewest definitions at the functional level. The highest mean number of definitions was in the error category.

The finding that the largest mean number of correct definitions given by the low group to specialized vocabulary was of the descriptive type does not agree entirely with Gerstein's hypothesis that the descriptive method characterized children's thought until age eight and that the conceptual method is well established by age eleven.

Summary

An inspection of the mean number of responses in each category for both groups in response to specialized vocabulary revealed that the majority of correct definitions were split between the conceptual and the descriptive categories with few responses of the functional type. While the high group exhibited more conceptual than descriptive responses the low group exhibited more descriptive than conceptual responses. This pattern of knowledge, consisting of a split between the conceptual and descriptive categories with few functional responses would seem to disagree with Gerstein's (1949) hypothesis that the descriptive method characterizes children's thought until age eight, and that the conceptual

level is well established by age eleven. The subjects appeared to exhibit a pattern of knowledge of specialized vocabulary different from that hypothesized by Gerstein and from their knowledge of core vocabulary.

V. COMPARISON OF THE RESPONSES TO A CORE AND SPECIALIZED VOCABULARY

All responses given by each subject were categorized according to the three level scale hypothesized by Gerstein (1949). Qualitative vocabulary scores were obtained for each method of definition for both core and specialized vocabulary for each subject. The mean number and standard deviation for each level of definiton were calculated for both groups and both types of vocabulary. In order to compare the differences between the responses given to core and specialized vocabulary, two-tailed "t" tests of the significance of the differences between the means for the two types of vocabulary for both groups in each category of definition were undertaken. The level of probability that was considered significant was $p < .05$. While the program for the "t" test showed the significance of the differences, it did not indicate the direction of the difference. An inspection of the means was undertaken to indicate which group the difference favoured. The results are presented in Tables VI and VII.

<u>High Group</u>

The findings, as presented in Table VI, indicate that the responses given by the high group to core and specialized vocabulary differed significantly in three of the four categories. An inspection of the means indicated that the high group gave the descriptive type of

response more often to specialized vocabulary than to core vocabulary, the functional type of response significantly more often to core vocabulary than to specialized vocabulary, and the error type of response significantly more often to specialized than to core vocabulary. The difference between the mean number of conceptual responses given by the high group for core and specialized vocabulary was not found to be significant.

The differences cited above are an accurate reflection of the quality of the definitions given. Responses given to core vocabulary were most often at the conceptual level, e.g. "Mars" - "a planet in space". A smaller number were of the functional variety, e.g. "gown" -"something which people wear". A small number were at the descriptive level, e.g. "envelope" - "a piece of paper", and there were a few errors, e.g. "devout" - "to give a lot of time to, to sacrifice for". However, definitions given in response to specialized vocabulary, tended to be either of the conceptual type, and of a high quality, e.g. "triangle"- "a three-sided figure," or of the descriptive type or an error, and therefore of poor quality, e.g. "cubic" - "it's a square, its, a box could be a cubic thing"; "divisor" - "in arithmetic the numeral you are dividing into". This represents a significant difference in the quality of definition given in response to core and specialized vocabulary.

In summary, when the responses of the high group to the sixty word vocabulary test of core and specialized vocabulary were analyzed, significant differences between the qualitative scores of core and specialized vocabularies were obtained for three of the four categories

of definitions--Descriptive, Functional and Error Categories. The difference in the number of conceptual responses was not significant, although definitions of this type were given slightly more often in response to specialized than to core vocabulary. The results tend to indicate that there is a qualitative difference in the knowledge of core and specialized vocabulary, as they are represented in this study, by the group of high achievers, as they were defined in this study.

Low Group

The findings as presented in Table VII, indicate that the responses given by the low group to core and specialized vocabulary differed significantly in three of the four categories--Descriptive, Functional and Error categories. An inspection of the means showed that the low group gave the descriptive type of response more often for specialized than for core vocabulary, the functional type of responses more often for core vocabulary than for specialized vocabulary, and the error type of response more often for specialized vocabulary than for core vocabulary. The difference between the mean number of definitions given by the low group for core and specialized vocabulary at the conceptual level was not found to be significant. These results are similar to those cited for the high group.

In summary, it would appear that there is a qualitative difference in the knowledge of core and specialized vocabulary, as they are represented in this study, of the low group studied. This difference is shown by the significant differences between the mean values in three of the four levels of definitions given in response to core and specialized vocabulary. These differences represent a different pattern of knowledge

for both the high and the low group for core and specialized vocabulary. Knowledge of a core vocabulary tended to be in terms of the functional - conceptual with a smaller number of descriptive definitions, as hypothesized by Gerstein for this age group. However, knowledge of specialized vocabulary did not exhibit this pattern. While fewer specialized words were known by both groups, as exhibited by the greater number of errors for specialized vocabulary, the words known tended to exhibit a split between the descriptive and conceptual types of definition. The high group tended to give conceptual definitions while the low group tended to give descriptive definitions. Knowledge of the two types of vocabulary appears, therefore, to differ significantly.

V. ERRORS MADE IN RESPONSE TO A CORE AND A SPECIALIZED VOCABULARY

Feifel's research (1952) concluded that the six most common types of errors were: incorrect demonstration, misinterpretation, wrong definition, clang association, repetition without explanation, and omission. All error responses were re-classified according to Feifel's system. The results for each group for both core and specialized vocabulary were tabulated and the results converted into percentages. These results are presented in Tables VIII and IX.

Analysis of the Error category up to this point has indicated that both the high group and the low group made more errors in response to specialized vocabulary than in response to core vocabulary.

The results indicate that in three of the four cases, with the exception of the high achiever's responses to core vocabulary, the omission type of error was the most common. Among the errors made by

the group of high achievers to core vocabulary, repetition without explanation was the most common type while the omission type was the second most common. The second most common type of error given by the low group in response to core vocabulary was the repetition without explanation type while the wrong definition type of error was the second most common given by both groups in response to specialized vocabulary. The third most common type of error given by both groups in response to core vocabulary was wrong definition while in response to a specialized vocabulary it was the repetition without explanation. Misinterpretation was the only other type of error that was given with any frequency. There were few clang association errors and no incorrect demonstration errors. The latter may have been a product of the nature of the words used in the test, or possibly the subjects were influenced by the fact that responses were being tape recorded and a demonstration type of definition did not seem suitable.

While the results tend to indicate that the types of errors made in response to core and specialized vocabulary are similar, two important differences seem to be evident. It may be seen that for both groups the wrong definition type of error accounts for almost twice the percentage of errors for the specialized vocabulary as for the core vocabulary. Thus, it would appear that the problem of associating an incorrect concept with a word is far greater for specialized than for core vocabulary. In addition, it may be noted that the repetition without explanation type of error constitutes the largest percentage of errors made by the group of high achievers in response to a core vocabulary. The prevelance of this type of error may indicate that the better students have some awareness of the meanings of a large number of words which they

TABLE VIII

FREQUENCY OF RESPONSES IN EACH ERROR CATEGORY FOR THE HIGH GROUP

Error type	Core		Specialized	
	f	%	f	%
Incorrect Demonstration	0	0.0	0	0.0
Misinterpretation	7	9.6	21	11.9
Wrong Definition	12	16.4	56	31.8
Clang Association	0	0.0	0	0.0
Repetition Without Explanation	29	39.7	27	15.4
Omission	25	34.3	72	40.9
Total	73	100.0	176	100.0

f = frequency
% = percentage

TABLE IX

FREQUENCY OF RESPONSES IN EACH ERROR CATEGORY FOR THE LOW GROUP

Error Type	Core		Specialized	
	f	%	f	%
Incorrect Demonstration	0	0.0	0	0.0
Misinterpretation	27	13.1	21	7.4
Wrong Definition	29	14.1	79	27.4
Clang Association	10	4.9	3	1.1
Repetition Without Explanation	38	18.6	38	13.4
Omission	101	49.3	143	50.3
Total	205	100.0	284	100.0

f = frequency
% = percentage

cannot verbalize, possibly because of lack of instruction or practice in verbal communication that is precise. It also indicates a lack of awareness of the logical necessities of definition as a process to both categorize a word and differentiate it from other words. Considering the ability of this group of students, this may be an unnecessary lacking.

VI. RELATIONSHIP BETWEEN QUALITATIVE LEVEL OF CORE AND SPECIALIZED VOCABULARY AND SEX, READING SCORE, INTELLIGENCE QUOTIENT AND AGE.

After the definitions of each subject had been rated, the number of definitions of each type for both vocabularies was tabulated. Using Multiple Linear Regression as a basis for analysis, models were written which used the information concerning intelligence quotient, reading scores, sex and age collected for each subject as predictors of the qualitative level of vocabulary of the subject. Since the sample was composed of two groups, a high and a low group of achievers, group membership was held constant in each case to avoid a spuriously high correlation. The results are presented below.

Sex

Russell (1954) in a study of the development of vocabulary from grades four to twelve stated that the results suggested the possibility of earlier specialization of vocabulary development of girls, but that no final evidence was available. The results of this study are presented in Table X.

The results indicate that sex is a predictor only of the descriptive category of response for core vocabulary. In no other case was the level of probability significant. Therefore it would appear that sex is not a

TABLE X

RELATIONSHIP BETWEEN THE QUALITATIVE LEVEL OF CORE AND SPECIALIZED VOCABULARY AND SEX

Qualitative Category	Core F-ratio	p	Specialized F-ratio	p
Descriptive	4.6676	.0357*	1.8772	.1770
Functional	3.8135	.0567	0.0437	.8358
Conceptual	0.1894	.6654	2.9731	.0911
Error	0.2360	.6293	0.4305	.5149

*Significant $p < .05$

significant predictor of qualitative vocabulary score.

It should be noted that no attempt has been made to equate the boys and the girls on the basis of intelligence, reading achievement, arithmetic achievement or even total numbers. The results of the vocabulary testing are reported but investigation is not carried further.

Reading Score

The relationship between the qualitative level of core vocabulary and reading score, when group membership is held constant, is presented in Table XI. It can be seen that both standardized reading test scores are significant predictors of the conceptual and error levels. These are significant at the .05 level. It would seem possible that this may be explained by the fact that both reading tests present questions in a multiple-choice format, composed of answers, usually of an abstract nature, and incorrect distractors.

The relationship between the qualitative level of specialized vocabulary and reading score, when group membership is held constant, is presented in Table XIII. It can be seen that reading score is a significant predictor only of the error category in the case of one standardized reading test. This was significant at the .05 level.

Table XII presents the results of an analysis of the relationship between the qualitative level of a core vocabulary and the results of two standardized reading tests when both group membership and intelligence quotient are held constant. It can be seen that in this case, the reading test score is a significant predictor only of the results of the error category. The results are significant at the .05 level. It is possible that reading score is no longer a significant predictor of the conceptual

TABLE XI

RELATIONSHIP BETWEEN QUALITATIVE LEVEL OF CORE VOCABULARY AND READING SCORE

Qualitative Category	California Reading Test F-ration	p	STEP Reading Test F-ratio	p
Descriptive	0.1720	.6802	0.0201	.8880
Functional	0.0380	.8463	1.8084	.1850
Conceptual	10.4531	.0022*	4.8089	.0332*
Error	28.0155	.0000*	37.3027	..0000*

*Significant $p < .05$

TABLE XII

RELATIONSHIP BETWEEN QUALITATIVE LEVEL OF CORE VOCABULARY AND READING SCORE WITH INTELLIGENCE QUOTIENT CONSTANT

Qualitative Category	California Reading Test F-ratio	p	STEP Reading Test F-ratio	p
Descriptive	1.1395	.2912	0.6514	.4239
Functional	0.0091	.9244	2.9473	.0926
Conceptual	3.4943	.0678	0.3905	.5351
Error	16.4205	.0002*	22.8785	.0000*

*Significant $p < .05$

TABLE XIII

RELATIONSHIP BETWEEN THE QUALITATIVE LEVEL OF SPECIALIZED VOCABULARY AND STANDARDIZED READING TEST SCORE

Qualitative Category	California Reading Test F-ratio	p	STEP Reading Test F-ratio	p
Descriptive	0.1344	.7156	0.5110	.4782
Functional	0.0435	.8357	0.2018	.6553
Conceptual	3.4302	.0702	0.1324	.7175
Error	4.8181	.0330*	1.9834	.1655

$p < .05$

TABLE XIV

RELATIONSHIP BETWEEN THE QUALITATIVE LEVEL OF SPECIALIZED VOCABULARY AND STANDARDIZED READING TEST SCORE WITH INTELLIGENCE QUOTIENT CONSTANT

Qualitative Category	California Reading Test F-ratio	p	STEP Reading Test F-ratio	p
Descriptive	0.2670	.6078	0.8895	.3504
Functional	0.2683	.6069	0.0459	.8313
Conceptual	1.5674	.2168	0.2435	.6240
Error	2.1659	.1478	0.2998	.5866

level over and above the affect of intelligence. Thus, when group membership and intelligence quotient are held constant, reading test score is not an important predictor of the qualitative level of core vocabulary.

The relationship between the qualitative level of specialized vocabulary and reading score, when group membership and intelligence quotient are held constant, is presented in Table XIV. It can be seen that, in this case, reading score is not a significant predictor. It would appear that the addition of reading score to intelligence quotient and group membership adds little to the predictive value.

Intelligence Quotient

The results of an analysis of the relationship between the qualitative level of core and specialized vocabulary and the verbal and non-verbal IQ scores of the Lorge-Thorndike Intelligence Test are presented in Tables XV and XVI. From Table XV, it can be seen that non-verbal intelligence quotient is not a significant predictor of the qualitative level of core vocabulary. The verbal intelligence quotient is a significant predictor of the conceptual and error types of definition only. The results are significant at the .05 level. From Table XVI it can be seen that neither the verbal nor non-verbal intelligence quotient is a significant predictor of the qualitative level of a specialized vocabulary when group membership is held constant. It is possible that this finding may be explained by the similarity that exists between the reading test and the paper-and-pencil intelligence test but does not exist between the intelligence test and the arithmetic test.

TABLE XV

RELATIONSHIP BETWEEN THE QUALITATIVE LEVEL OF CORE VOCABULARY AND INTELLIGENCE QUOTIENT

Qualitative Category	Verbal I.Q. Score F-ratio	p	Non-verbal I.Q. score F-ratio	p
Descriptive	1.1118	.2970	0.0005	.9831
Functional	0.0501	.8238	0.1099	.7417
Conceptual	11.9670	.0012*	0.3661	.5480
Error	10.1420	.0026*	0.2058	.6521

*Significant $p < .05$

TABLE XVI

RELATIONSHIP BETWEEN THE QUALITATIVE LEVEL OF SPECIALIZED VOCABULARY AND INTELLIGENCE QUOTIENT

Qualitative Category	Verbal I.Q. Score F-ratio	p	Non-verbal I.Q. Score F-ratio	p
Descriptive	0.0334	.8558	1.1459	.2898
Functional	0.2584	.6135	0.0453	.8324
Conceptual	2.3465	.1321	0.7290	.3974
Error	3.3824	.0721	0.0652	.7996

Age

The age range of the subjects in the study was small, from 133 months to 168 months, with a mean of 145.30 and a standard deviation of 7.4169. Any results must be viewed in the light of this restricted range. The results of analysis are presented in Table XVII.

The results indicate that age is a significant predictor of core error category and specialized descriptive category only, when group membership is held constant. The results are significant at the .05 level. In all other cases, the slight correlations are not statistically significant.

Group Membership

Statistical analysis using group membership is a predictor of the qualitative vocabulary scores of the subjects was undertaken. As stated in Chapter III, the two groups differed significantly, at the .05 level, in age, verbal and non-verbal I.Q. score, reading achievement and achievement in mathematics. Thus, group membership represents a combination of variables. The results are presented in Table XVIII.

The results indicate that group membership is significant for all levels of qualitative vocabulary score for both core and specialized vocabulary with the exception of the functional level. The results are significant at the .05 level. Thus, it would appear that the combination of variables represented by group membership is a better predictor of the qualitative vocabulary scores of subjects than any of these variables alone, that is, intelligence quotient, standardized reading test score, sex and age.

TABLE XVII

RELATIONSHIP BETWEEN QUALITATIVE LEVEL OF CORE AND SPECIALIZED VOCABULARY AND AGE

Qualitative Category	Core F-ratio	p	Specialized F-ratio	p
Descriptive	0.2403	.6262	4.8064	.0332*
Functional	0.2469	.6215	0.3953	.5327
Conceptual	0.6146	.4369	0.7036	.4057
Error	5.1790	.0274*	2.5093	.1197

*Significant<p .05

TABLE XVIII

RELATIONSHIP BETWEEN QUALITATIVE LEVEL OF CORE AND SPECIALIZED VOCABULARY AND GROUP MEMBERSHIP

Qualitative Category	Core F-ratio	p	Specialized F-ratio	p
Descriptive	5.9535	.0184*	10.3197	.0023*
Functional	0.6456	.4256	0.6669	.4181
Conceptual	36.0113	.0000*	52.6504	.0000*
Error	44.2554	.0000*	27.4731	.0000*

*Significant $p < .05$

Summary

In summary it would appear that each of the variables, reading score, intelligence quotient, age and sex are significant predictors of part of the qualitative level of core and specialized vocabulary of the subjects, when group membership is held constant. However, no single variable would seem to be as good a predictor as the combination of variables represented in group membership.

VII. ANALYSIS OF THE LOGICAL QUALITY OF THE DEFINITIONS

In Chapter III an attempt was made to further refine Gerstein's categories by outlining the logical types of definitions which fell within the three psychological categories. This was an attempt to collate the logical and psychological characteristics of definitions. There were six logical types of definitions which were included under the Descriptive category--the Ostensive Method, Denotative Method, Implicative Method, Range Definition, Method of Synthesis and Differentia Only. There were four logical types of definitions which were included under the Functional category--the Manipulative Operational Definition, Implicative Method, "if-clause" Method and Set of Operations Definition. Under the conceptual category were included three logical types of definitions--the Synonym Definition, Genus Only and Definition Through Classification types. These are described further in Chapter III.

The Descriptive definitions given by the high group were mainly of the Denotative, Differentia Only and Range Definition types in terms of their logical characteristics. The Denotative Method, e.g. "pair"-"a pair of pants" was most often used while the Range Definition type, e.g.

"ambitious"-"is hurry" was the second most common type. Definitions by Differentia Only, e.g. "rectangle"-"two sides are long and two short", were also common. No definitions of the Ostensive Method were noted and very few of the Synthesis type. A small number of subjects used the Implicative Method almost exclusively, e.g. "east"-"Montreal is east of here".

The Descriptive definitions given by the low group were very similar in their logical characteristics to those given by the high group. However, the Denotative Method was used more often by the low group while the Range Definition was used less often.

The Functional responses of the high group were most often of the Set of Operations type of definitions, e.g. "tap"-"is the thing you turn to put the water on", with a smaller number of Manipulative Operational Definitions. Very few "if-clause" definitions were given e.g., "haste"-"if you went fast all the time that would be haste". The same tendency was noted for a small number of people to use the Implicative Method almost exclusively.

The Functional responses of the low group were most often of the Manipulative Operational type, e.g. "zero"-"in some numbers you use zero for a place holder" with a smaller number of Set of Operations Definitions. Few "if-clause" definitions were given and a small number of people used the Implicate Method of defining almost exclusively.

The Conceptual responses of the high group were more often of the Genus Only and Synonym Unmodified types than of the Synonym Modified or Classification types in terms of their logical characteristics. Both

the Synonym Only, e.g. "gown" - "a dress", and Genus Only types of definition e.g. "diamond" - "a jewel", attempt to classify the term but make no attempt to differentiate it from other members of the class. The Synonym Modified, e.g. "roar" - "a loud growl", and particularly the Classification type of definition, e.g. "orange" - "a type of citrus fruit sweeter than a lemon", attempt not only to classify the term but also to differentiate it from similar terms. As a result definitions of the Synonym Unmodified and Genus Only variety are not as logically sound as the Synonym Modified and Classification types of definitions. These results may indicate a lack of awareness of the logical criteria for definition on the part of the high group.

The Conceptual responses of the low group were in general of the Synonym Unmodified and Genus Only types and the comments made for the high group generally apply to the low group. There was, however, a slightly smaller proportion of Synonym Modified and Classification type responses for the low group.

In summary, a number of conclusions seem evident. The responses of both the high and the low group were remarkably similar in terms of their logical characteristics. Only at the functional level did the two groups show a difference in the logical characteristics of their definitions, the high group giving the Set of Operations type of definition and the low group the Manipulative Operational type of definition. Previous analysis of the groups revealed that they differed significantly in terms of ability and achievement in other areas. It is surprising therefore that they did not differ in terms of the logical characteristics of their definitions. This conclusion may be the result of a small sample or it

could indicate that both groups have received little training in the process of definitions and the superior group has not yet reached its potential.

In addition, a number of subjects were noted who defined almost exclusively by the Implicative Method. A smaller number of subjects defined almost exclusively by one word definitions which appeared to be definitions by association e.g. "high"-"up"; "temperature"-"hot". Many of these were of the Range type of definition. While the percentage of the subjects who restricted themselves to either of these types of definition was small, they were evident. This type of subject might profit greatly from instruction in the process of defining.

VIII SUMMARY

This chapter has presented the results of the investigation. The performance of both groups on a test of core vocabulary was analyzed as was the performance of the groups on a test of specialized vocabulary. A comparison was made of the responses given by the high group to core and specialized vocabulary. A similiar type of analysis was carried out for the low group. The types of errors made in response to core and specialized vocabulary were discussed. Performance on a test of core and specialized vocabulary was related to sex, reading score, intelligence quotient and age. A brief analysis was made of the logical quality of the definitions given by both groups in response to core and specialized vocabulary.

CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

The present study was designed to investigate the general hypothesis that there is a significant difference between the knowledge of core and specialized mathematics vocabulary, as they are defined in this study, among grade six students.

The sample for the study consisted of fifty grade six students who attended two of the Edmonton public schools during the school year 1966-67. Twenty-five had received a percentile rank of seventy-five or better on the Seeing Through Arithmetic Test, grade six level, administered throughout the system and twenty-five had received a percentile rank of twenty-five or lower on the same examination. The results for the Lorge-Thorndike Intelligence Test, form A, level 3, the California Reading Test, form y, and the STEP, reading section, form 4A were recorded for each subject together with his age in months and his sex.

The results of an analysis of the significance of the difference between the means for the high and the low groups on the Lorge-Thorndike Intelligence Test, the California Reading Test, the STEP, reading section as well as age in months and sex indicated that the two groups differed significantly, at the .05 level, on each of these variables, with the exception of sex.

A sixty word vocabulary test, designed specifically for use in this study, was given to each subject individually. The test was composed of thirty core and thirty specialized words. All verbatim responses were recorded, transcribed and qualitatively analyzed using the scale

hypothesized by Gerstein (1949). According to this scale each correct response was placed in one of three categories--Descriptive, Functional or Conceptual category. Incorrect responses were placed in the Error category. All responses in the Error category were further classified according to the findings of research by Feifel (1952) concerning the most common types of errors.

The means and standard deviations for each category of definition for both types of vocabulary and both groups were calculated. Statistical analysis by means of "t" tests of the significance of the difference between the means was undertaken. In addition, Multiple Linear Regression was used to investigate the significance of each of the variables as predictors of the qualitative level of vocabulary responses. An analysis was undertaken of the types of errors most commonly given in response to core and specialized vocabulary along with a brief analysis of the logical qualities of the definitions.

In the present chapter the findings are presented in summary form and general conclusions are drawn. A discussion of the specific limitations of the findings is followed by a discussion of possible implications and recommendations for further research.

I. SUMMARY OF FINDINGS

1. Both the high group and the low group exhibited a preponderance of definitions at the functional-conceptual level when dealing with core vocabulary.

2. The responses of the high group to a specialized vocabulary

were primarily of the conceptual type with a smaller number of descriptive definitions and very few functional responses. The responses of the low group to specialized vocabulary were primarily of the descriptive variety with a smaller number of conceptual definitions and very few functional responses.

3. A comparison of the responses given by the high group to core and specialized vocabulary indicated that the high group gave the descriptive type of response more often to specialized vocabulary than to core vocabulary, the functional type of response more often to core vocabulary than to specialized vocabulary, and the error type of response more often to specialized than to core vocabulary. The difference between the mean number of conceptual responses was not significant. In all cases $p<.05$ was the level of significance.

4. A comparison of the responses given by the low group to core and specialized vocabulary indicated that the low group gave the descriptive type of response more often for specialized than for core vocabulary, the functional type of response more often for core vocabulary than for specialized vocabulary, and the error type of response more often for specialized than for core vocabulary. The difference between the mean number of conceptual responses was not significant.

5. The most common types of errors were the omission, repetition without explanation and wrong definition types of errors. There were few clang and no incorrect demonstration errors. In general, the types of errors were similiar for both groups.

6. Sex differences in the qualitative level of core and specialized vocabulary knowledge were not found to be significant when group membership was held constant.

7. Reading score was a significant predictor only of the conceptual and error categories of responses to a core vocabulary when group membership was held constant.

8. Verbal I.Q. was a significant predictor only of the conceptual and error categories of responses to a core vocabulary when group membership was held constant. Non-verbal I.Q. was not a significant predictor of the qualitative vocabulary score of either a core or a specialized vocabulary when group membership was held constant.

9. Age was a significant predictor only of the error type of responses given to a core vocabulary and the descriptive type of response given to a specialized vocabulary when group membership was held constant.

10. An analysis of the logical qualities of the definitions given in response to a core and a specialized vocabulary failed to reveal significant differences in the logical quality of the definitions given by the high group and the low group.

II. GENERAL CONCLUSIONS

The results of the study indicated that the knowledge of core vocabulary of both the high and the low groups tended to be in terms of the functional-conceptual. This is in agreement with the hypothesis of Gerstein (1949) that the conceptual level is well established by age eleven, and the research of Russell and Saadeh (1962) which revealed a majority of functional-conceptual choices at the grade six level. However, knowledge of specialized vocabulary did not exhibit this pattern. There was a split between the descriptive and conceptual types of responses. The low group had a majority of descriptive responses while the high group

had a majority of conceptual responses. There were very few functional responses. These findings for the specialized vocabulary are not in agreement with Gerstein's hypothesis. They appear to indicate that there was a qualitative difference in both groups' knowledge of core and specialized vocabulary as they have been defined in this study.

The findings indicated that both groups differed significantly in three of the four qualitative levels when knowledge of core and specialized vocabulary was compared. For both groups the pattern of knowledge was similar; more functional definitions were given in response to core vocabulary while more descriptive and error responses were given in response to specialized vocabulary. The difference in the mean number of conceptual definitions was not significant. These differences appear to indicate that there was a qualitative difference in the knowledge of core and specialized vocabulary, as they have been defined in this study, of both groups. This conclusion tends to be in agreement with Russell (1954) who indicated the possibility of specific development of the specialized vocabularies.

While a number of variables, such as reading score and verbal I.Q. were successful in predicting part of the qualitative level of the vocabulary responses, the findings appear to indicate that a combination of variables, in the form of group membership, was the best predictor of the qualitative level of vocabulary responses. Standardized reading test score and verbal intelligence quotient were significant predictors of the conceptual and error responses to core vocabulary. This may indicate the existence of a common factor in these three types of tests.

A brief analysis of the logical quality of the definitions given by both groups, failed to reveal distinct differences in the logical

quality of the responses given by the high and the low groups. In the light of the differing abilities and achievements of the two groups in other areas, this result is surprising.

III. IMPLICATIONS

The results of a study of this nature would seem to be of interest to those designing curricula for reading. Reading courses in the upper elementary school appear to have assumed that the skills taught in the prescribed period would transfer to other reading tasks, even though the bulk of reading materials are of the narrative type. If the child's knowledge of core and specialized vocabulary differs, as this study indicates, this assumption of transferability should be reconsidered. It may be necessary to include in a well-balanced reading program a variety of materials which may require specific reading techniques, of which specific vocabulary development may be a part. Another alternative may be to include as part of the reading program a series of activities designed to teach the young reader not only more word meanings but also more about the nature of word meaning. This type of understanding may prove to be more transferable to other reading situations.

For the reading teacher in the classroom, the possibility of qualitative differences in the knowledge of core and specialized vocabularies on the part of her students means that she can no longer assume that a child is ready to read in the content areas or a content area on the basis of general reading examinations which test only core vocabulary. Russell (1957) has stated that:

> more diagnostic tests in terms of subject-matter

> areas and different vocabulary achievements are needed for thorough study of children's vocabularies (p. 372).

The results of the study and particularly of the brief analysis of the logical quality of the definitions, seem to indicate the necessity of providing more instruction in the process of definition. A greater understanding of the logical criteria of definition may foster in the student a more rigorous attitude towards the use of language. This more rigorous attitude might not only have beneficial effects upon the students ability to communicate but may also aid in improving the students ability to use language in thinking.

IV. LIMITATIONS

The results of this study should be considered in the light of certain limitations inherent in its design. One of these limitations concerns the process of qualitative analysis as a means of analyzing vocabulary responses. Although the investigator has attempted to make the categories used in the study as explicit as possible, no classification system can cover all variety of responses and some subjectivity in scoring is inevitable. While reliability studies indicated that this subjectivity was not sufficient to change the major findings of the investigation, the accuracy of the analysis would be improved if the categories became more explicit. In addition, while it appears that the Gerstein method of classifying verbal responses is in accord with the bulk of research available to date, it is possible that a more valid method of categorizing responses will evolve as research on verbal concepts continues.

It is also possible that the process of defining is in part a

function of the stimulus word. As indicated earlier, certain words leant themselves to certain methods of definition. Further research in this area may indicate that the nature of the stimulus word will have to be taken into consideration when classifying definitions.

The task of verbal definition of words in isolation represents only one aspect of word knowledge. Both Courtney, bucknam and Durrell (1946) and Hurlbert (1954) have indicated that the tasks of verbal recall and recognition of a correct definition are in some ways dissimiliar. It would seem possible, therefore, that the results would benefit from verification using another method of testing.

V. SUGGESTIONS FOR FURTHER RESEARCH

As a result of the study, the need for research in the following areas seem evident.

1. There is a need for the results of this study to be verified with a larger random sample of subjects and with different specialized vocabularies.

2. There is a need for the investigation of the relationship between children's knowledge of core and specialized vocabulary by means of other verbal tasks. These might take the form of recognition type tasks or tasks involving the knowledge of the meanings of terms in context.

3. There is a need for the refinement of the method of qualitative analysis of verbal definitions. This refinement may take two forms. There is a need for a more valid classification scale which might result from research into the development of verbal concepts. There is a need

for a more reliable scale which might result from attempts to describe more completely and explicitly the categories of the best scale available at the time.

4. There is a need for an analysis of the verbal definitions of elementary school children in terms of the logical criteria of the process of definition. This might take the form of a developmental study or a comparison of high and low groups at one grade level.

5. It would appear that there is a need for an analysis of verbal definitions in relation to the nature of the verbal stimulus and the referents for which they stand.

6. There is a need for further research on the relationship between concrete and abstract verbal concepts and specific reading comprehension skills.

BIBLIOGRAPHY

BIBLIOGRAPHY

Ausubel, D. P. The Psychology of Meaningful Verbal Learning. New York: Grune and Stratton, 1963.

Baranyai, E. H. Verbal Comprehension in Hungarian Children of 8-10 Years. British Journal of Educational Psychology, 1958, 28, 262-265.

Berwick, M. The Semantic Method for Testing Vocabulary. Journal of Experimental Education, 1959, 28, 123-141.

Binet, A. and Simon T. The Development of Intelligence in Children. New Jersey: Publication of the Training School at Vineland, 1916.

Bond, G. L. and Fay, L. C. A Comparison of the Performance of Good and Poor Readers on the Individual Items of the Stanford-Binet Scale, Forms L and M. Journal of Educational Research, 1950, XLIII, 475-479.

Black, M. Problems of Analysis. Ithaca, New York: Cornell University Press, 1954.

Bourne, L. E. Jr. Human Conceptual Behaviour. Boston: Allyn and Bacon, Inc., 1966.

Braun, Jean J. Relation Between Concept Formation Ability and Reading Achievement at Three Developmental Levels. Child Development, 1963, XXXIV, 675-682.

Brown, R. Words and Things. Glencoe, Illinois: The Free Press, 1958.

Bruner, J. J. Going Beyond the Information Given. A Symposium held at the University of Colorado, 1957.

Bruner, J. J. Goodnow, J.S. and Austin, G. A. A Study of Thinking. New York: Science Editions Inc., 1962.

Bruner, J.S. Studies in Cognitive Growth. New York: John Wiley and Sons, Inc., 1966.

Buckingham, G. E. The Relationship Between Vocabulary and Ability in First Year Algebra. The Mathematics Teacher, 1937, 30, 76-79.

Buhler, K. The Mental Development of the Child. In the Evolution of Thinkers. London: Kegan, Paul, Trench & Trubner, 1930.

Burks, H. F. and Bruce, P. The Characteristics of Poor and Good Readers as Disclosed by the Wechsler Intelligence Scale for Children. Journal of Educational Psychology, 1955, XLVI, 488-493.

Burns, D. G. A Note on the Responses Made by Secondary School Children in Their Definitions of Words. British Journal of Educational Psychology, 1960, XXX, 30 - 39,

Buros, O. K. (ed.). The Fourth Mental Measurement Yearbook. New Jersey: The Gryphen Press, 1953.

Buros, O. K. (ed.). The Fifth Mental Measurement Yearbook. New Jersey: The Gryphen Press, 1959.

Buros, O. K. (ed.). The Sixth Mental Measurement Yearbook. New Jersey: The Gryphen Press, 1965.

Buswell, G. T. and John, L. The Development of Children's Mathematics Vocabulary. In Research in the Three R's. New York: Harper Brothers, 1958.

Carey, J. E. and Goss, A. E. The Role of Verbal Responses in the Conceptual Sorting Behaviour of Children. Journal of Genetic Psychology. 1957, 92, 69-74.

Carroll, J. B. Words, Meanings and Concepts. Harvard Education Review, 1964, 34, 178-202 (a).

Carroll, J. B. Language and Thought. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1964. (b).

Chase, C. I. An Application of Levels of Concept Formation to Measurement of Vocabulary. Journal of Educational Research. 1961, 55, 75-78.

Courtney, D., Bucknam, M., E., and Durrell, D. Multiple Choice Recall Versus Oral and Written Recall. Journal of Educational Research, 1946, XXXIV, 458-461.

Curti, M. W. Child Development - X Concepts. In Encyclopedia of Educational Research. New York: The Macmillan Company, 1950.

Dale, E. and Razek, T. Bibliography of Vocabulary Studies. Columbus: Bureau of Educational Research and Service, 1963.

Eagle, E. The Relationship of Certain Reading Abilities to Success in Mathematics. The Mathematics Teacher, 1948, 41, 175-179.

Educational Testing Service. Sequential Tests of Educational Progress - Technical Report. Princeton: Educational Testing Service, 1963.

Ennis, R. H. Operational Definitions. American Educational Research Journal, 1964, 1, 183-201.

Ennis, R. H. A Concept of Critical Thinking. Harvard Education Review, 1966, 32, 81-111.

Ewert, P. H. and Lambert, J. F. The Effect of Verbal Instruction Upon the Formation of a Concept. Journal of General Psychology, 1932, 6, 400-413.

Fay, L. C. The Relationship Between Reading Skills and Selected Areas of Sixth Grade Achievement, Journal of Educational Research, 1950, 43, 571-577.

Feifel, H. Qualitative Differences in the Vocabulary Responses of Normals and Abnormals. Genetic Psychology Monographs, 1949, 39, 151-204.

Feifel, H. An Analysis of the Word Definition Errors of Children. Journal of Psychology, 1952, 33, 65-77.

Feifel, H. and Lorge, I. Qualitative Differences in the Vocabulary Responses of Children, Journal of Educational Research, 1950, 41, 1-18.

Flavell, John H. The Developmental Psychology of Jean Piaget. New York: D. Van Nostrand Company, Inc., 1963.

Fodor, J. A. and Katz, J. J. (ed.). The Structure of Language. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1964.

Gage, N. L. Handbook of Research on Teaching. Chicago: Rand McNally and Co., 1963.

Gerstein, R. A. A Suggested Method for Analyzing and Extending the Use of Bellvue-Wechsler Vocabulary Responses. Journal of Consulting Psychology. 1949, 13, 366-370.

Goss, A. E. and Maylan, M.C. Conceptual Block-Sorting As A Function of Type and Degree of Mastery of Discriminative Verbal Responses. Journal of Genetic Psychology, 1958, 93, 191-198.

Goss, A. E. Verbal Mediating Responses and Concept Formation. Psychological Review, 1961, 68, 248-274.

Grant, M. A. A Qualitative Analysis of the Vocabulary Responses of Good Readers and Poor Readers. Unpublished Master's thesis, University of Alberta, 1965.

Gray, W. S. and Holmes, E. The Development of Meaning Vocabulary in Reading. Chicago: University of Chicago, 1938.

Gray, W. S Improving Reading in Content Fields. Chicago: University of Chicago Press, 1947.

Green, H. J. A Qualitative Method for Scoring the Vocabulary Test of the New Revision of the Stanford-Binet. Unpublished Master's thesis, Liland Stanford Junior University, 1931.

Harootnian, B. Intellectual Abilities and Reading Achievement. Elementary School Journal, 1966, 66, 388-392.

Hartung, M. L. et, al. Seeing Through Arithmetic. Chicago: Scott Foresman and Company, 1958.

Hayakawa, S. I. Language in Action. New York: Harcourt, Brace and Company, 1941.

Hurlbert, D. The Relative Value of Recall and Recognition Techniques for Measuring Precise Knowledge of Word Meaning--Nouns, Verbs, Adjectives. Journal of Educational Research, 1954, XLVII, 561-576.

Inhelder, Barbel and Piaget, J. The Growth of Logical Thinking. New York: Basic Books, Inc., 1958.

Jan-Tausch, J. Concrete Thinking As A Factor in Reading Retardation. Unpublished Doctoral Thesis, Rutgers University, 1960.

Jay, Edith S. A Factor Study of Reading Tasks. Unpublished Doctoral Thesis, University of Chicago, 1950.

Johnson, H. C. The Effect of Instruction in Mathematics Vocabulary Upon Problem Solving in Arithmetic, Journal of Educational Research, 1944, XXXVIII, 97-110.

Johnson, J. T. On the Nature of Problem Solving in Arithmetic, Journal of Educational Research, 1949, XLIII, 110-115.

Kingston, A. J. Vocabulary Development, Journal of Reading, 1965, 32, 265-271.

Kress, R. A. Jr. An Investigation of the Relationship Between Concept Formation and Achievement in Reading. Temple University, 1955, Dissertation Abstracts, 1956, XVI, 573-574.

Kruglov, L. P. Qualitative Differences in the Vocabulary Choices of Children as Revealed in a Multiple-Choice Test, Journal of Educational Psychology. 1953, 44, 229-243.

Lado, R. Linguistics Across Cultures. Ann Arbor: University of Michigan Press, 1957.

Lessenger, W. E. Reading Difficulties in Arithmetical Computation, Journal of Educational Research, 1925, XI, 287-291.

Loban, W. B. The Language of Elementary School Children, Champaign, Illinois: National Council of Teachers of English, Research Report No. 1, 1963.

Luria, A. R. The Development of the Regulatory Role of Speech. In The Cognitive Processes: Readings, Toronto: Prentice-Hall Inc., 1964.

Maltz, H. E. Ontogenetic Change in the Meaning of Concepts as Measured by the Sementic Differential, Child Development, 1963, 34, 667-674.

Marx, B. A Study of the First Fifty Words of the Stanford-Binet Vocabulary. Unpublished Master's thesis, Leland Stanford Junior University, 1928.

Melton, A.W. Categories of Human Learning. New York: Academic Press, 1964.

National Council of Teachers of Mathematics. Arithmetic in General Education. New York: Bureau of Publications, Columbia University, 1941.

National Society for the Study of Education. The Teaching of Arithmetic. Chicago: University of Chicago Press: 1951.

Ogden, C. K. and Richards, I. A. The Meaning of Meaning. New York: Harcourt, Brace and Company, 1956.

Ohlsen, R. L. The Effects of Concretion and Abstraction on Vocabulary Performance of Mentally Retarded, Average and Bright Children. Unpublished Doctoral thesis, University of Kansas, 1963.

Osgood, C. E., Suci G.J., Tannenbaum, P, H. The Measurement of Meaning. Champaign, Illinois: University of Illinois Press, 1957.

Phillips, C. The Relationship Between Arithmetic Achievement and Vocabulary Knowledge of Elementary Mathematics, Arithmetic Teacher, 1960, 1, 240-242.

Piaget, J. The Language and Thought of the Child. London: Routledge and Kegan Paul Ltd., 1959.

Pressey, L. C. and Moore, W.S. The Growth of Mathematics Vocabulary from the Third Grade Through High School, The School Review., 1932, 40, 449-454.

Rasmussen, E. A. and Archer, E. T. Concept Identification As a Function of Language Pretraining and Task Complexity. Journal of Experimental Psychology. 1961, 61, 437-441.

Reichard, S., Schneider, M., and Rapaport, B. The Development of Concept Formation in Children. American Journal of Orthopsychiatry, 1944, 14, 156-161.

Robinson, R. Definition. Oxford: The Clarendon Press, 1954.

Russell, D. H. Research on the Processes of Thinking with Some Applications to Reading, Elementary English, 1965, 42, 370-378.

Russell, D. H. The Dimensions of Children's Meaning Vocabularies in Grades Four Through Twelve. Berkeley: University of California Press, 1954.

Russell, D. H. Children's Thinking. New York: Ginn and Company, 1956.

Russell, D. H. Concepts. In Encyclopedia of Educational Research, New York: MacMillan Co., 1960.

Russell, D. H. and Saadeh, I. Q. Qualitative Levels in Children's Vocabularies. Journal of Educational Psychology, 1962, 53, 170-174.

Scheerer, Martin Cognitive Theory, Handbook of Social Psychology, Reading, Mass: Addison-Wesley Publishing Co. Inc., 1954.

Serra, Mary C. How to Develop Concepts and Their Verbal Representation, The Elementary School Journal, 1953, 53, 275-285.

Spencer, P. L. and Russell, D. H. Reading in Arithmetic. In Instruction in Arithmetic, Washington: National Council of Teachers of Mathematics, 1960.

Stacey, C. L. and Portnay, B. A Study of the Differential Responses on the Vocabulary Sub-Test of the Wechsler Intelligence Scale for Children, Journal of Clinical Psychology, 1950, 6, 401-403 (a).

Stacey, C. L. and Portnay, B. A Study of the Differential Responses of the Vocabulary Sub-Test of the Wechsler-Bellvue Intelligence Scale. Journal of Clinical Psychology, 1950, 7, 144-148, (b).

Stacey, C. L. and Spanier, S. W. Differential Responses Among College Students on the Vocabulary Subtest of the Wechsler Intelligence Scale. Journal of Educational Psychology, 1954, 45, 29-35.

Stauffer, R. G. Getting Meaning in Reading and Arithmetic. Newark: Proceedings of the 37th Annual Education Conference, University of Delaware, 1955.

Stauffer, R. G. Concept Development and Reading. Reading Teacher, 1965, 14, 100-105.

Stauffer, R. G. A Vocabulary Study Comparing Reading, Arithmetic, Health and Science Texts. The Reading Teacher, 1966, 20, 141-147.

Terman, Lewis M. and Merrill, M. A. Measuring Intelligence. New York: Houghton Miffin Company, 1937.

Terman, L. M., and Merrill, M. A. Stanford-Binet Intelligence Scale, Manual for the Third Revision Form L-M. Boston: Houghton Miffin Company, 1960.

Thurstone, L. L. and Thurstone, T. G. Factorial Studies of Intelligence. Chicago: University of Chicago, 1941.

Tiegs, E. W. and Clark, W. W. California Achievement Tests Complete Battery Manual. Los Angeles: California Test Bureau, 1957.

Treacy, J. P. The Relationship of Reading Skills to the Ability to Solve Arithmetic Problems, Journal of Educational Research, 1944, XXXVIII, 86-95.

Vanderlinde, L. F. An Experimental Study of the Effect of the Direct Study of Quantitative Vocabulary on the Arithmetic Problem Solving Ability of Fifth Grade Pupils. Unpublished Doctoral thesis, Michigan State University, 1962.

Van Engen, H. The Formation of Concepts, The Learning of Mathematics: Its Theory and Practices, Washington: National Council of Teachers of Mathematics, 1953.

Vinacke, W. Edgar. The Psychology of Thinking. Toronto: The McGraw-Hill Book Co. Inc., 1952.

Vygotsky, L. S. Thought and Language. New York: M. I. T. Press and John Wiley and Sons, Inc., 1962.

Watts, A. F. The Language and Mental Development of Children. London: George G. Harrap and Co. Ltd., 1944.

Wechsler, David. The Measurement and Appraisal of Adult Intelligence. Baltimore: The Williams and Williams Company, 1944.

Welch, L. A. A Preliminary Investigation of Some Aspects of the Hierarchical Development of Concepts. Journal of Genetic Psychology, 1940, 22, 175-206.

Welch, L. and Long, L. The Higher Structural Phases of Concept Formation in Children. Journal of Psychology, 1940, 9, 59-95.

Werner, H. and Kaplan E. The Acquisition of Word Meanings: A Developmental Study. Evanston: Child Development Publications, 1952.

Werner, H. and Kaplan, B. Symbol Formation. New York: John Wiley and Sons, Inc., 1963.

Wickers, A. R. The Ability of Good and Poor Readers to Abstract. Unpublished Doctoral thesis, University of Chicago, 1963.

Wolman, R. N. and Barker, E. N. A Developmental Study of Word Definitions. Journal of Genetic Psychology, 1961, 107, 159-166.

APPENDICES

APPENDIX A

VOCABULARY TEST

1. orange
2. cubic*
3. triangle*
4. pair*
5. rectangle*
6. geometry*
7. altitude*
8. kilograms*
9. plus*
10. juggler
11. hastily
12. east*
13. expensive
14. puddle
15. straw
16. sad
17. below*
18. divisor*
19. depth*
20. tap
21. southward*
22. measurement*
23. devout
24. comedy
25. diamond
26. gown
27. skill
28. lucky
29. brunette
30. Mars
31. thirteen*
32. parallelograms*
33. zero*
34. diameter*
35. unseen
36. liters*
37. metric*
38. roar
39. brief
40. pictograph*
41. envelope
42. calendar*
43. eyelash
44. give
45. quotient*
46. muzzle
47. scorch
48. forbid
49. temperature*
50. aloud
51. lowest*
52. high
53. fifth*
54. graphs*
55. lecture
56. ambitious
57. flat*
58. haste
59. seven*
60. circular*

Note: Specialized vocabulary words are marked by an asterik (*).

APPENDIX B

SELECTED EXAMPLES OF ORAL RESPONSES

ORANGE

Descriptive

It's a round ball.

Functional

Something that you eat.

Conceptual

A type of citrus fruit.
A color that is darker than yellow.

CUBIC

Descriptive

A block; a building.
A cube of ice.

Functional

Used in volume.

Conceptual

A kind of measurement.

Error

A square.
It's like a foot, it's all square the same size all over.

TRIANGLE

Descriptive

It has three corners; It has three sides.

Functional

Something you can play in an orchestra.

Conceptual

A three-sided figure.
An instrument.

Error

A rectangular shape.
A square.

PAIR

Descriptive

A pair of pants.

Conceptual

A group of two; A couple.

Error

Like a piece of fruit you eat.

RECTANGLE

Descriptive

Is a box which has two longer sides and two shorter sides.

Functional

Is something that you use in arithmetic.

Conceptual

A four sided figure; A plane figure.

Error

A three cornered thing.

GEOMETRY

Descriptive

Sort of like arithmetic.

Functional

The measurement of figures.

Conceptual

A branch of mathematics consisting of the shapes.

Error

The study of land.

ALTITUDE

Descriptive

How high up you are.
Like aplane flies in the sky, loses or gains altitude.

Functional

Measuring a distance above the earth.

Conceptual

The height of something, sometimes from sea level.

Error

A line running across the earth.

KILOGRAM

Descriptive

A measure of wheat or grain or things like that.

Functional

A means of measuring a quantity.

Conceptual

A measure of quantity.

Error

Electricity.

PLUS

Descriptive

A sign to add something.

Functional

When you add something.

Conceptual

An arithmetic statement.
Addition.

Error

When you plus something.

JUGGLER

Descriptive

A person who throws things around.

Functional

Something you do, like throwing things up in the air.

Conceptual

A performer, maybe in a circus.

Error

Somebody that is slow.

HASTILY

Descriptive

Can't wait.

Functional

To hurry.

Conceptual

Quickly; rapidly done.

Error

To have poor judgement.

EAST

Descriptive

Montreal is east of here.

Conceptual

A direction.

EXPENSIVE

Descriptive

Lots of money.

Functional

Taking a lot of money to pay for it.

Conceptual

Worth quite a bit; opposite of cheap.

PUDDLE

Descriptive

Water out in the street.

Conceptual

Small pool of water.

Error

It's a certain type of dog.

STRAW

Descriptive

Sort of like wheat or something.

Functional

Something that you drink out of.

Conceptual

A dried plant.
A narrow tube.

SAD

Descriptive

When a boy gets hurt he is very sad.

Functional

When you are feeling very glum.

Conceptual

An expression; an emotion.
Depressed feelings.

Error

To be sad.

BELOW

Descriptive

A place, I guess.

Functional

To go down.

Conceptual

Under; underneath.

Error

Something that is below you.

DIVISOR

Descriptive

When you divide a fraction, the little one is called the divisor.

Functional

The thing which you divide by.

Conceptual

The number that you divide into another number.

Error

Something which is being divided.

DEPTH

Descriptive

Something below sea level.

Functional

When you're way below the mountains you're in depth.

Conceptual

Distance downward.

Error

Something in the middle.

TAP

Descriptive

Tap somebody on the shoulder.

Functional

To hit lightly.
Is the thing you turn on to put the water on.

Conceptual

Water spout.
A noise.
A soft knock.

Error

It's sort of like to knock real hard.

SOUTHWARD

Descriptive

A car can go southward or a ship can go southward.

Functional

A direction that is to go.

Conceptual

A direction.

Error

South.

MEASUREMENT

Descriptive

The numbers that are taken when something is measured.

Functional

To take the width or distance of something.

Conceptual

A form of taking things or record weight, size or this type of thing.

Error

A piece or particle of something.

DEVOUT

Conceptual

Religious

Error

Giving all you have.

COMEDY

Descriptive

Something that is on T.V.

Functional

Something that makes you laugh.

Conceptual

Entertainment.
Something hilarious.

DIAMOND

Descriptive

Something on a ring.

Functional

Valuable.

Conceptual

A jewel, a gem; a precious stone.

GOWN

Functional

Something you wear.

Conceptual

A type of cloak; a dress.

Error

A noise.

SKILL

Descriptive

Something that someone has, comes naturally.

Functional

Something you are able to do well.

Conceptual

Ability to do something.

Error

When you have lots of skill.

LUCKY

Descriptive

Something that happens, like a miracle.

Functional

To win something.

Conceptual

Something fortunate; really a form of coincidence.

Error

Unlucky.

BRUNETTE

Descriptive

Hair.

Conceptual

A brownish color.

Error

A person that's brown.

MARS

Descriptive

Something out of the world.

Conceptual

A planet.

THIRTEEN

Descriptive

Beginning of teenagers.

Conceptual

A number; a numeral.

PARALLELOGRAM

Descriptive

It has four sides and they are parallel.

Conceptual

A figure, a kind of shape having four sides, two of which are parallel with each other and another two with each other.

Error

A many sided figure.

ZERO

Descriptive

A circle with nothing inside it.

Functional

In some numbers you use a zero for a place holder.

Conceptual

A number meaning nothing.

Error

A negative.

DIAMETER

Descriptive

A line.

Conceptual

Distance across a sphere through the middle.

Error

The distance around.

UNSEEN

Descriptive

Somebody that you have not seen before.

Functional

You didn't see it.

Conceptual

Not visible to you.

LITER

Conceptual

A form of measurement.

Error

Mother cat has litters of kittens.
To litter something in the street.

METRIC

Descriptive

A math word.

Conceptual

A type of measurement.

Error

A shape.

ROAR

Descriptive

Like the roar of an engine or a lion.

Functional

To make a loud noise.

Conceptual

A loud noise; a loud growl; a loud sound.

BRIEF

Descriptive

A short paragraph in a story.

Functional

Something that goes on just for a moment.

Conceptual

Very short; a short period of time.

PICTOGRAPH

Conceptual

A diagram.

Error

A story told with pictures.

ENVELOPE

Descriptive

A piece of paper.

Functional

A thing used for mailing letters.

Conceptual

Paper enclosures in which you may put a letter.

CALENDAR

Descriptive

Something with the days and weeks on it.

Functional

What we keep track of days with.

Conceptual

A record of days and months or years.

Error

A round shape.

EYELASH

Descriptive

Something that is long and is on your eye.

Functional

They keep dust and dirt out of your eye.

Conceptual

The hair on the eyeball.

GIVE

Descriptive

To give somebody a candy.

Functional

Something like hand it to someone.

Conceptual

An action by which somebody else receives from you.

Error

To take.

QUOTIENT

Descriptive

A number.

Conceptual

The answer when you divide.

Error

To say what someone else has said.

MUZZLE

Functional

Something you put over a dog's mouth and it can't bite then.

Conceptual

The front part of something, as of a gun.

Error

To have lots of muscle.

SCORCH

Descriptive

Something like a fire.

<u>Functional</u>

To burn.

<u>Conceptual</u>

Slightly burnt.

<u>Error</u>

Keep score of things.

FORBID

<u>Descriptive</u>

Somewhere where you shouldn't go.

<u>Functional</u>

To tell not to do.

<u>Error</u>

To not want something.

TEMPERATURE

<u>Descriptive</u>

If the air is hot or cold or something.

<u>Functional</u>

It tells you what it is going to be like out.

<u>Conceptual</u>

The degree of warmth or coldness.

ALOUD

<u>Descriptive</u>

Yelling.

<u>Functional</u>

To say something with everyone hearing.

<u>Error</u>

Opposite of forbid.

LOWEST

Descriptive

Is, for instance, the lowest part of a swimming pool that is deep.

Functional

When you are the lowest mark in a test.

Conceptual

The farthest down part of anything.

Error

A low point.

HIGH

Descriptive

Like in a high rope.

Functional

You jumped high.

Conceptual

Is a rather elevated position.

Error

When something is high.

FIFTH

Descriptive

A grade you come out of when you go into six.

Conceptual

A measurement but shows in sequence.

Error

There are fifty different geometric shapes.

GRAPH

Descriptive

A paper with something giving measures of the temperature or something.

Functional

To record things.

Conceptual

A chart.

Error

He grabs it out of your hand.

LECTURE

Functional

To give a talk on.

Conceptual

A talk; a speech.

Error

Something like an election.

AMBITIOUS

Descriptive

Is hurry.

Functional

To want to go ahead and do something.

Conceptual

Industrious; eager to do things.

Error

To be frustrated or something.

FLAT

Descriptive

Laid down like a pancake.

Conceptual

A smooth surface.

Error

Opposite of flat.

HASTE

Descriptive

Movement.

Functional

To go quickly.

Conceptual

Quickly; rapidly.

Error

Not to like.

SEVEN

Descriptive

How old you might be.

Conceptual

An uneven number.

CIRCULAR

Descriptive

Like the top of a can is circular.

Conceptual

In a round form.

Error

His blood is very circular.